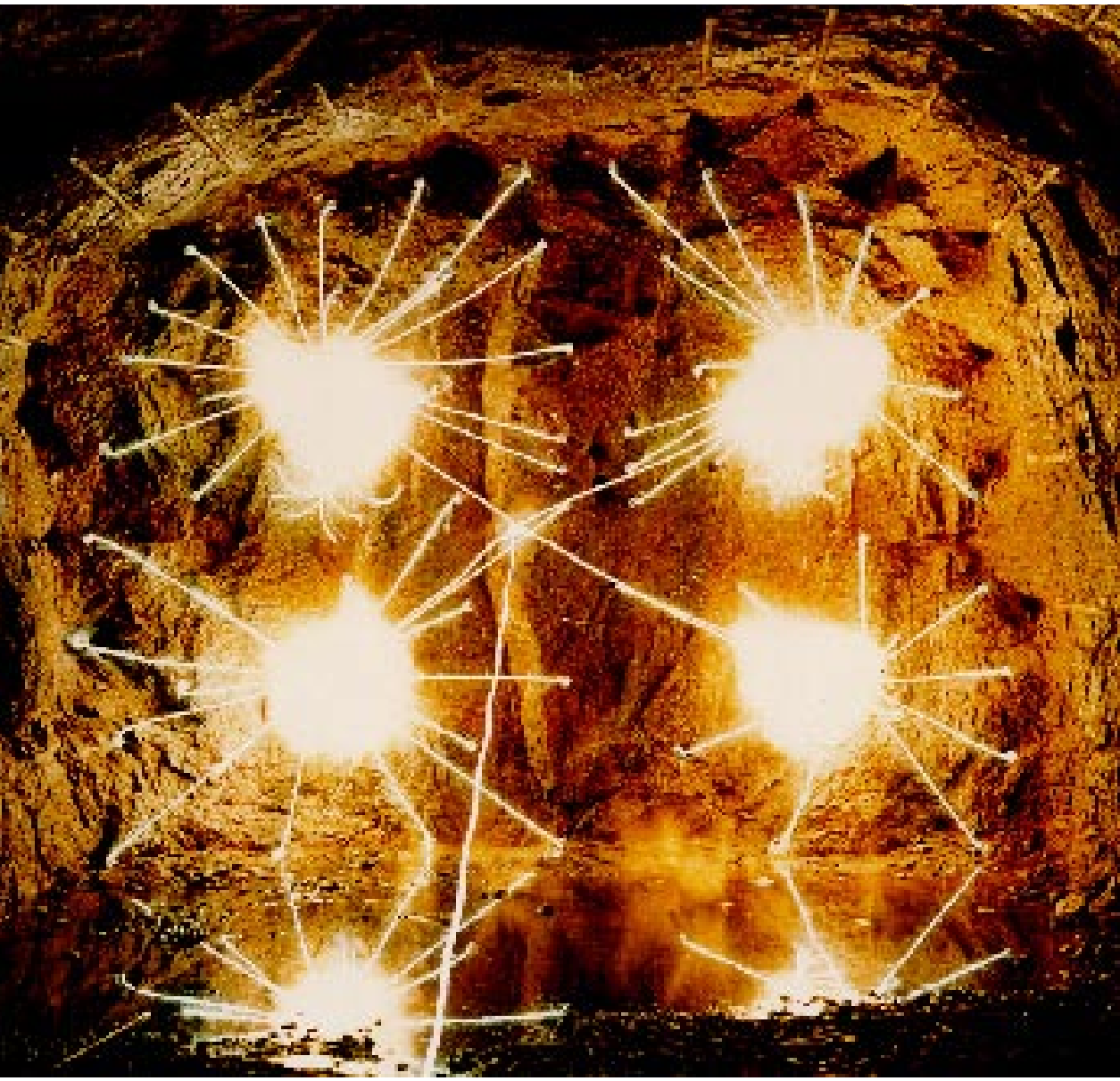
NONEL®

USER´S MANUAL



DYNO

Dyno Nobel

3590739

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas, THERE HAS BEEN PRESENTED TO THE

Commissioner of Patents

A PETITION PRAYING FOR THE GRANT OF LETTERS PATENT FOR AN ALLEGED NEW AND USEFUL INVENTION THE TITLE AND DESCRIPTION OF WHICH ARE CONTAINED IN THE SPECIFICATION OF WHICH A COPY IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PATENT OFFICE IN THE CLAIMANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID CLAIMANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A PATENT UNDER THE LAW.

NOW, THEREFORE, THESE **Letters Patent** ARE TO GRANT UNTO THE SAID CLAIMANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID CLAIMANT(S) FOR THE TERM OF SEVENTEEN YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF ISSUE FEES AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM MAKING, USING OR SELLING THE SAID INVENTION THROUGHOUT THE UNITED STATES.

In testimony whereof, I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington this sixth day of July, in the year of our Lord one thousand nine hundred and seventy-one, and of the Independence of the United States of America the one hundred and ninety-sixth.

Attest:

Edward [illegible] Jr.
Attesting Officer.

William E. Schuyler, Jr.
Commissioner of Patents.

FORM PO 1775
11-69

United States Patent

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[72] Inventor: Per-Anders Persson
Sodertalje, Sweden

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[73] Assignee Nitro-Nobel AB
Gyttorp, Sweden
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[33] Sweden
[31]

[54] FUSE
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[51] Int. Cl. C06c 5/04
[50] Field of Search 102/27, 70, 49.7; 89/1.01; 149/93

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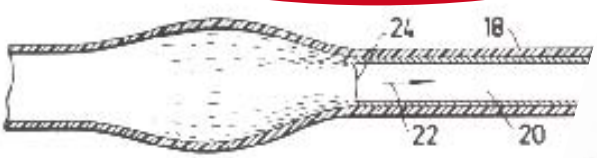
Primary Examiner—Verlin R. Pendegrass
Attorneys—A. Yates Dowell and A. Yates Dowell, Jr

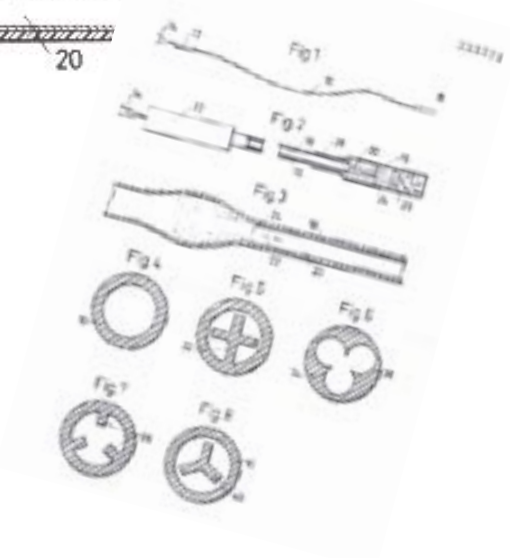
ABSTRACT: A fuse apparatus including an elongated hollow tube with a reactive substance coating the inner periphery and adapted to support a gaseous percussion wave throughout the length of the tube.

FUSE

This invention relates to a fuse.

More particularly this invention relates to a fuse for transfer of a detonation from an explosive charge to another or for initiating or igniting a detonation in an explosive charge. The fuse consists of an elongated wrapping having the shape of a tubular, rigid or flexible, duct which contains a quantity of explosive or other reactive substance which is distributed along the duct and which occupies a portion only of the cross-sectional area of the channel otherwise filled by gas of the duct.





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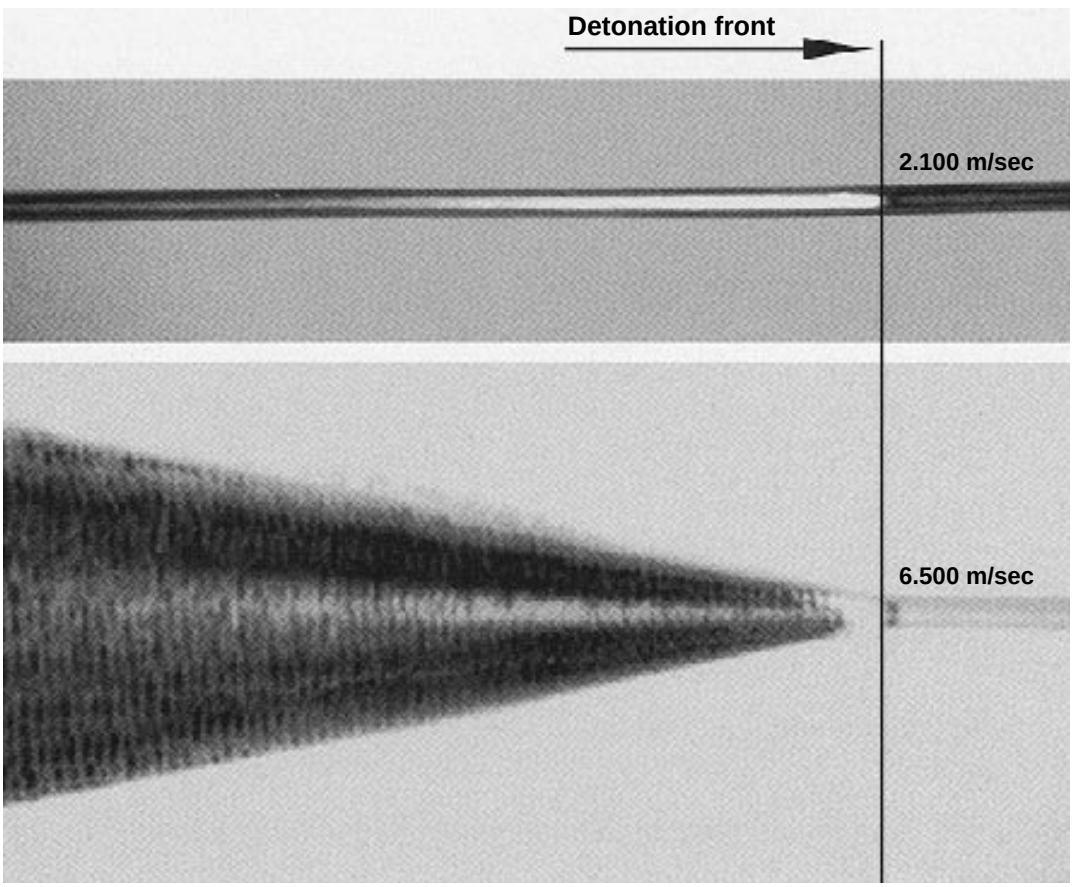
NONEL INITIATION
User´s manual

When the NONEL-system was introduced into the market 1973 by Dyno Nobel (then Nitro Nobel) the rock blasters got an initiation system that could replace the electric initiation system with its risks for unintentional initiation due to thunder-storms, leak currents, vagabonding currents, induction etc.

The NONEL-system is a shock tube system where the electric wires have been replaced by a plastic tube in which the inside walls are covered with a reactive material which can carry a shock wave through the tube with a velocity of 2.100 m/sec. The shock wave emits, at the end of the tube, a flash which is strong enough to initiate a detonator. The outer diameter of the plastic tube is 3 mm and it is not affected by the shock wave which goes through it, and as such it does not initiate the explosive that is in contact with the tube.

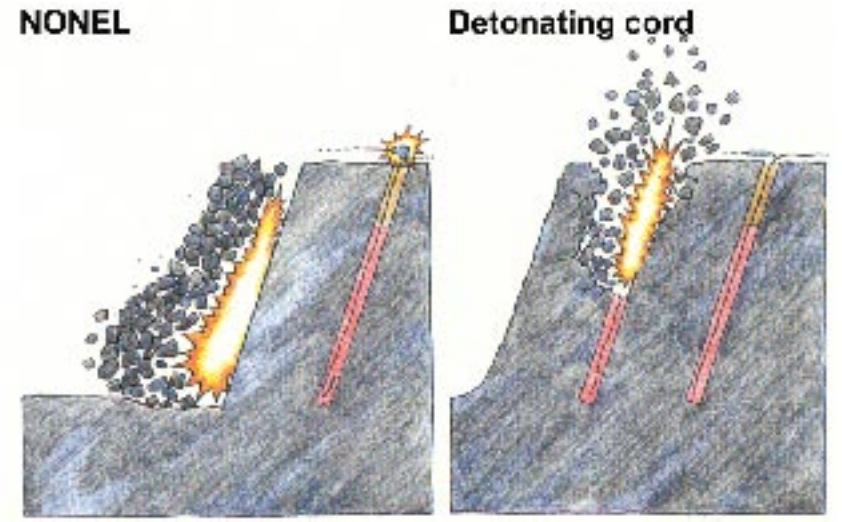
The NONEL-system is insensitive to electric influence, except for direct stroke of light-ning and is thus ideal when electric initiation is not possible nor permitted.

Unlike other non-electric initiation systems such as detonating cord the reaction in the NONEL tube is contained in it, while detonating cord, as the name indicates, detonates with a velocity of 6.500 m/sec and emits a high pressure shock wave.

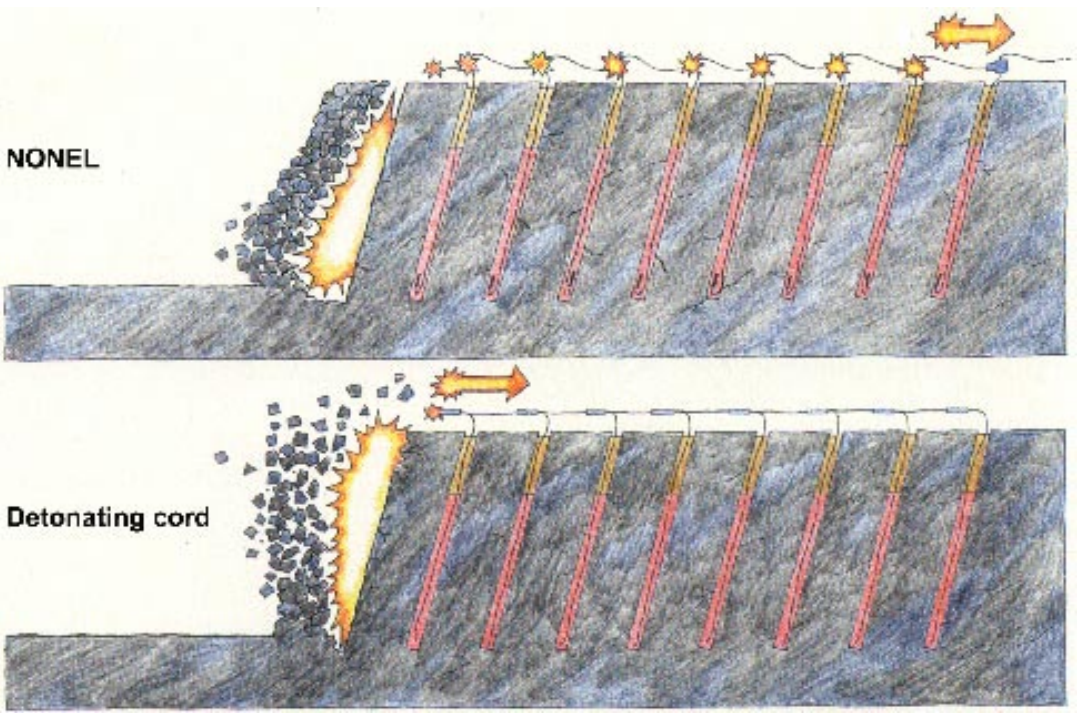


The shock wave is contained in the NONEL-tube while detonating cord detonates.

When using NONEL the explosive in the hole can be initiated from the bottom in an efficient way. Detonating cord initiates the explosive from the top of the hole and may, when using relatively insensitive explosives as ANFO and certain emulsion explosives it can cause dead pressing.



Top initiation with detonating cord often causes flyrock as the stemming is destroyed when the detonation wave goes through it.



When initiating with NONEL the surface activation is well ahead of the initiation of the explosive in the blasthole. A combination of U 500 in the blasthole and Eclip 42 on the surface most often gives the result that the whole round is activated before any rock movement starts.

The tube.

The NONEL tube is the original low energy fuse that was introdudced into the market in 1973 by Dyno Nobel (Then Nitro Nobel).
The tube, which has an outer diameter of 3 mm is internally coated with a reactive material. When the tube is subject to an initiatig impulse from, as an example, a shot shell primer or a highly intensive spark from a blasting machine, a shock wave is sent through the tube with a velocity of 2.100 m/sec. The shock wave is sufficiently strong to initiate a detonator but not strong enough to burst the tube and and affect the string of explosives it goes through.

3 layer NONEL tube

The tube is extruded in 3 layers each of which has different different properties. The innermost layer has good adhesive properties for the reactive material to adhere. The middle layer gives the tube its good tensile strength and the radial strength that is necessary to prevent the tube from bursting by the strain caused when the shock wave goes through it. The outermost layer has good abresive resistance and is also the layer where the coloring of the tube is done. The tube is UV-protected to withstand strong sunlight during extended exposure without the ability to initiate being affected.

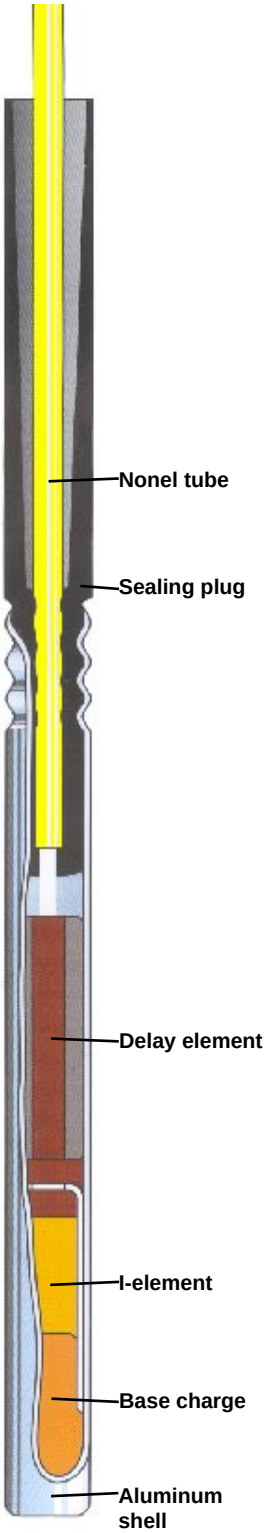
The NONEL tube is color coded. It is availabe in three standard colors.

* red for bench blasting detonators
* yellow for the tunnel series
* pink for surface connectors, Starters, bunch connectors and DynoLine

The NONEL tube may also be supplied in other colors if there is a need. An example is when several detonators are used in each hole and different colors facilitate the identification of the different detonators.

Dyno Nobel are introducing a new shocktube - NONEL W which is partly transparent. The shotfirer will then be able to more clearly differentiate a fired shocktube from an unfired one.

The detonator.



In 1992 Dyno Nobel introduced a completely new concept for detonators on the world market. It was the NPED detonator (**N**on **P**rimary **E**xposive **D**etonator) which does not contain any primary explosive. Primary explosives have been the greatest problem in manufacture and use of detonators and caused many accidents over the years due to their sensitivity to friction, heat and impact.

The primary explosive has in the NPED detonator been replaced by an initiation element (I-element) which contains a secondary explosive, in this case PETN. In the initiation element the firing impulse from the delay element is transformed from deflagration to detonation in a very short period of time which then initiates the base charge.

Detonators from Dyno Nobels are rated as strength No. 8 (according to Prior test 10) for safe and reliable initiation of modern explosives.

The detonator shell which is made of aluminum contains, not counting the I-element, a base charge of RDX (also a secondary explosive) that initiates the explosive. The total charge weight of explosive in the detonator is approx. 1 g.

On top of the I-element lies a delay element that delays the detonation a predetermined time after that it has been initiated by the flash from the NONEL tube. The delay times vary in different steps between 25 ms (0.025 sec) and 6000 ms (6 sec). The detonator is sealed by a rubber sealing plug which makes the detonator water restistant.

The delay time in a NONEL detonator is the sum of the delays in the delay element and the I-element plus the inherent delay in the NONEL tube which is 0.5 ms per meter tube. (The velocity of the shock wave in the tube is 2.100 m/sec). The nominal delay time is set with 6 m tube for blasthole detonators and 4.8 m for surface connectors.

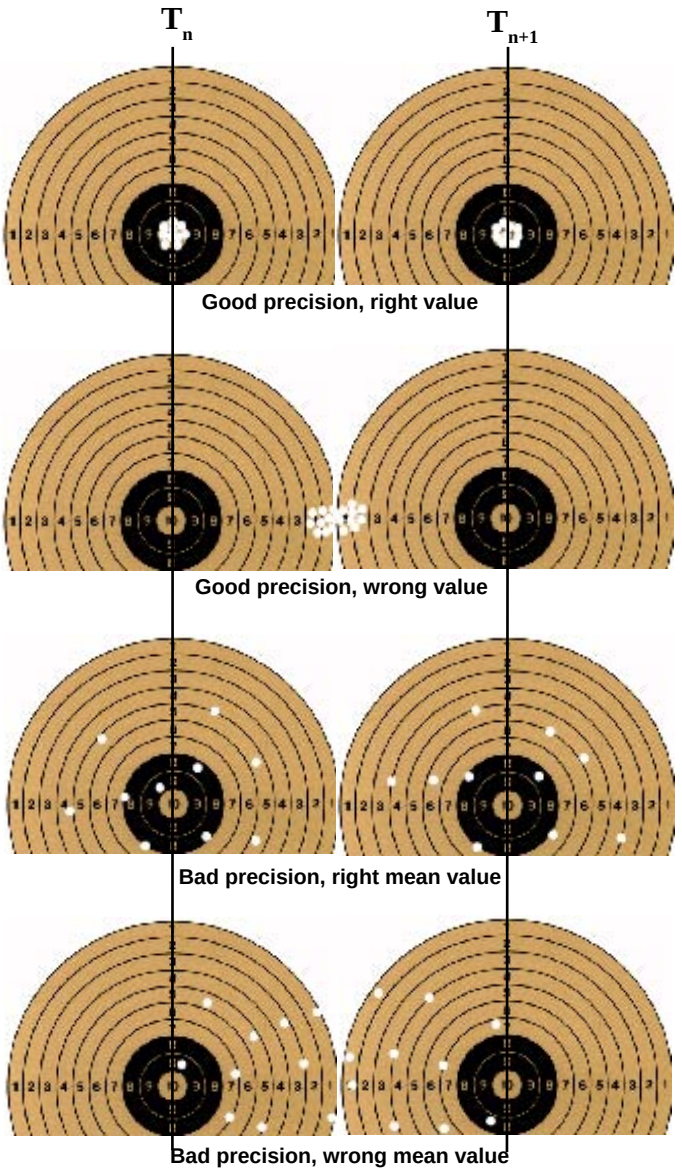
During the last 50 years research has been concentrated on better precision in timing of the detonator. Nevertheless there is an unavoidable scatter in timing between different detonators with the same nominal time. The scatter depends on small differences in raw material, packing density of the pyrotechnical composition and temperature along with the age of the detonator.

With the short delay times in the MS-series (0.025 sec) the margins are small to avoid overlapping. Overlapping is obtained if a detonator with higher period number detonates before one with lower period number.

According to the Swedish Standard, (SS 499 07 07) the scatter in a delay detonator should not be big enough to cause overlapping, that is; a detonator with a lower period number should always detonate before one with a higher period number.

However, Dyno Nobel has internally set the scatter limits tighter to avoid the risk of overlapping.

This explains why the precision in the three NONELsystems are different; NONEL UNIDET is best, NONEL LP has the largest scatter and NONEL MS is inbetween.



The detonator shells are marked with:
EXPLOSIVE
DANGER
DETONATOR
After DETONATOR the detonator delay time is marked. In the example in the photograph 500 MS.
After DANGER is the letter G which indicates that the detonator was manufactured in Gyttorp.

The connector block

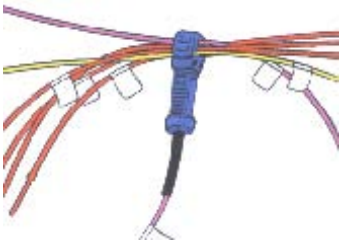
The NONEL system includes 8 different connector units, known as Ɛclip are included in the NONEL system.They are used to connect the NONEL MS series (Ɛclip 0) and NONEL UNIDET (Ɛclip 0, Ɛclip 17, Ɛclip 25, Ɛclip 42, Ɛclip 67, Ɛclip 109, Ɛclip 176, Ɛclip 285. Description of the systems are to be found on pages12 and 17.

Each connection block can initiate up to 8 tubes and the design of the block is such that the tubes are initiated in both directions.

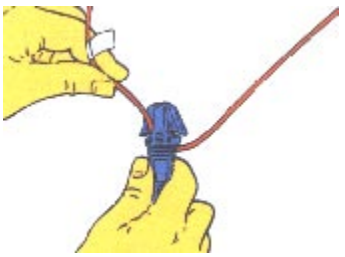
The function of the connecting blocks is to relay the shock wave through the NONEL tube in connection points.
This can be done with or without delay in the mini detonator which is placed in the connecting block.

Note: The connecting block Ɛclip is exclusively designed for transmission of the shock wave on the surface of the rock and must not be used in blastholes neighter for initiation of detonating cord.

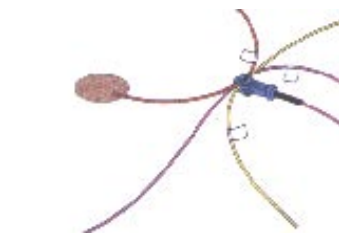
Connection of NONEL.



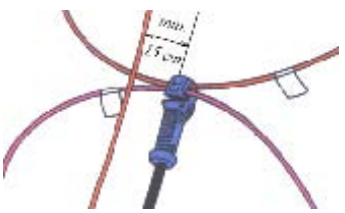
Ɛclip is designed for the initiation of up to 8 NONEL tubes.Thanks to the design of the block, the tubes are initated in both directions. The function of the Ɛclip can not be guaranteed when used together with shock tube systems of other brands. The Ɛclip should not be used to initiate detonating cord.



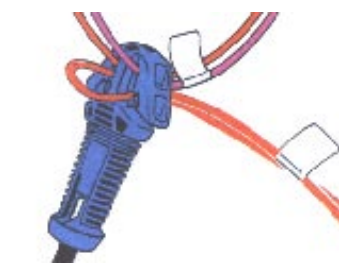
Connecting procedure.
It is simple to connect a round with Ɛclip, the connecting block is hooked to the tube of the blasthole detonator and then the rest of the tubes are pushed into the block with the thumbs or pulled into the block. If 8 tubes are to be connected into the block they should be placed into the block one by one to fit in place..
Make a point of introducing the NONEL tubes behind the grooves in the block.



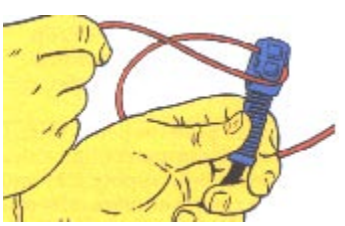
Carrying out the connection.
The connection should be done as close to the blasthole as possible. The NONEL tubes are tightened up for better overview of the connection. However, it should not be too tight especially it the round is to be covered with heavy mats.



Splinter.
The minidetonator in the Ɛclip gives a certain amount of splinter that may damage adjacent NONEL tubes. The safety distance from the connection block to adjacent tubes should be at least 15 cm.



Locking the tube.
The NONEL tubes should be connected inside the identification tag but at least 60 cm from the detonator or connection block. If there is a risk that the connected NONEL tube is pulled out of the block, it should be locked by connecting the tube on the other side of the block or by making a knot on the tube. To connect the fourth tube on each side keeps all the connected tubes effectively in place.



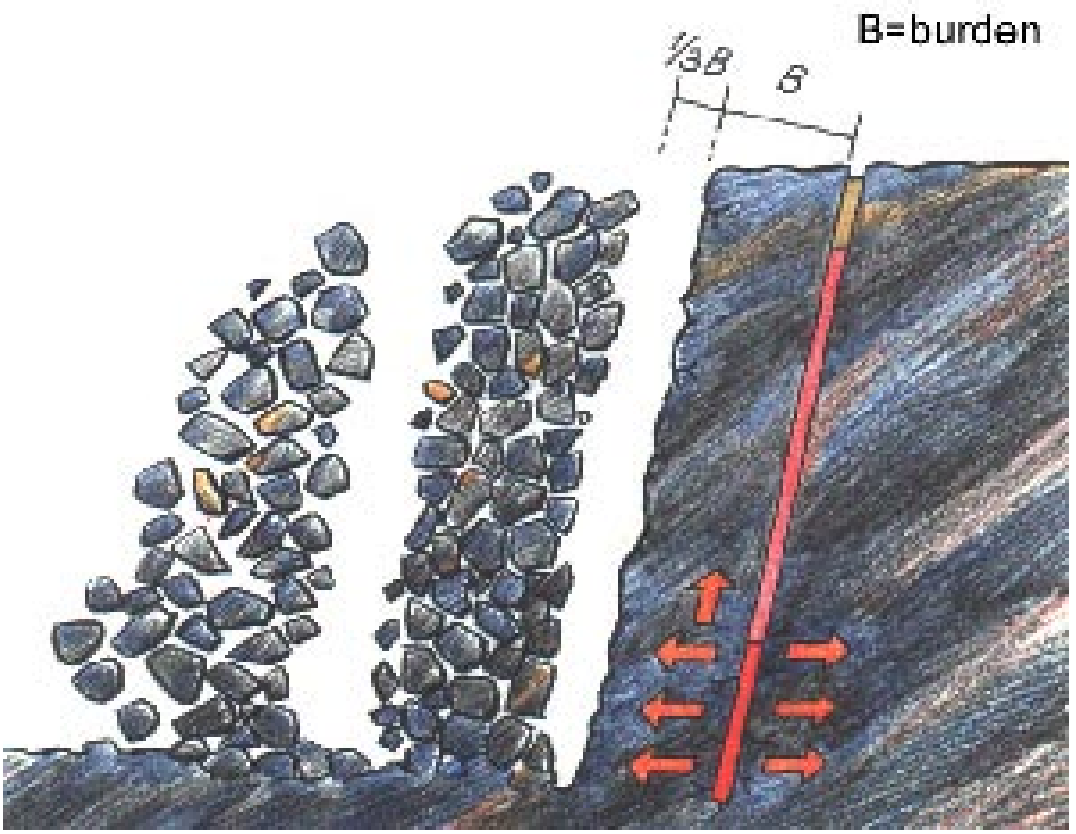
Reconnection
If it is necessary to remove connected tubes from the Ɛclip, bend the tube and pull according the the sketch at the left. To facilitate the removal of tubes, especially in cold weather, press the flap somewhat upwards with the thumb.
Reconnection must be carried out in a way that avoids damage to the plastic block or the tube.

Three different NONEL systems.

Three initiation systems based on NONEL are available:

NONEL MS
NONEL UNIDET
NONEL LP

NONEL MS and NONEL UNIDET are used for bench blasting and the delay times are adapted to the conditions prevailing in bench blasting.
In bench blasting with several rows of holes, it is important that the rock from the first row is given sufficient time to move forward before the rock from the second row starts to move. When the rock breaks by the explosive, its volume increases by approx. 50%. Room must be made for this increase in volume in a very short time. Studies have shown that the rock in one row should move forward 1/3 (one third) of the burden distance before next row detonates. The delay time may vary from 10 ms/m burden in hard rock to 30 ms/m in soft rock. Normally 15 ms/m can be used as a guide value.



NONEL MS is a conventional initiation system with 25 ms delay time between each period number. The short delay times remains from the times when small diameter blastholes and small burdens were predominent
Drill series 11 and 12 give burden distances of 1.0 to 1.5 m and then a delay time of 25 ms between the rows is suitable.
NONEL MS is used in bench blasting , underwater blasting and sublevel stoping.
NONEL UNIDET is an initiation system with uniform delay time in the blasthole detonator and variable delay time on the surface. The delay time in the blasthole is normally 500 ms (other delay times may be chosen), Then the firing sequence is built up on the surface with connecting units with their own delays.
Surface delay units are available with delay times from 0 ms to 285 ms which gives greater flexibility to adapt the firing sequence to burden distance and rock conditions.
NONEL LP is an initiation system developed for underground operations. The delay times are generally longer to give the blasted rock time enough to move forward in the confined spaces that are prevailing in tunnel blasting.¨

NOTE! Detonators intended for blastholes may not be used at the rock surface.

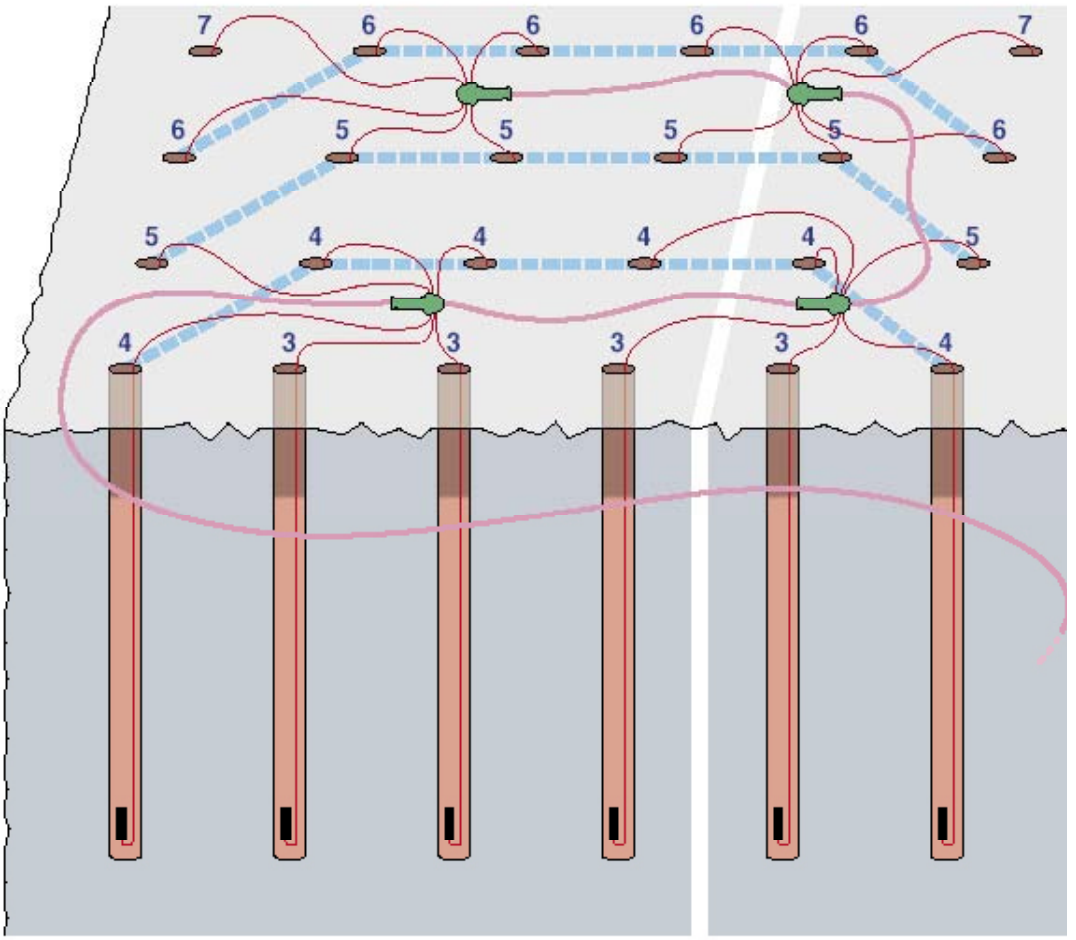
NONEL MS

NONEL MS is conventionally designed with 25 ms delay between the period numbers. The firing sequence is built up through the unique delay time that each period number has. The initiation of the round takes place on the surface with connection blocks with momentary initiation, Ɛclip 0. The system has 18 periods numbered from 3 to 20. The system starts with No.3 (with 75 ms delay) to allow all surface connectors to be activated before any explosive detonates causing a potentional cut off. (The NONEL-tube has an inherent delay of 0.5 m/sec as the shock wave velocity is 2.100 m/sec, that may cause problem in bigger rounds with long surface activation trunk line). With a 75 ms delay of the first period it is possible to have 150 m of tube in the connection units on the surface without risking parts of the round being cut off due to flyrock.

The NONEL tube to a detonator with lower nominal period number must not be more than 8 m longer than the tube of a detonator with the next higher period number.

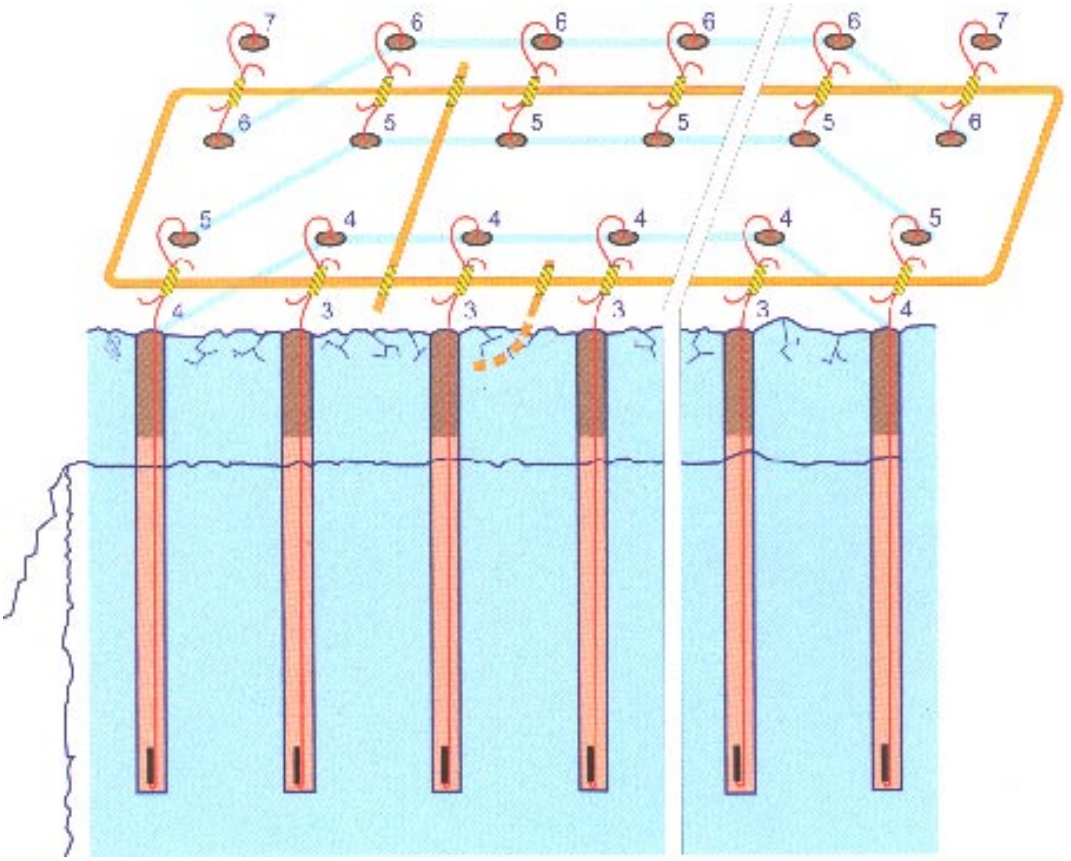
NONEL MS is mostly used in bench blasting above and under ground, in underwater blasting and sublevel stoping.

Firing pattern for bench blasting

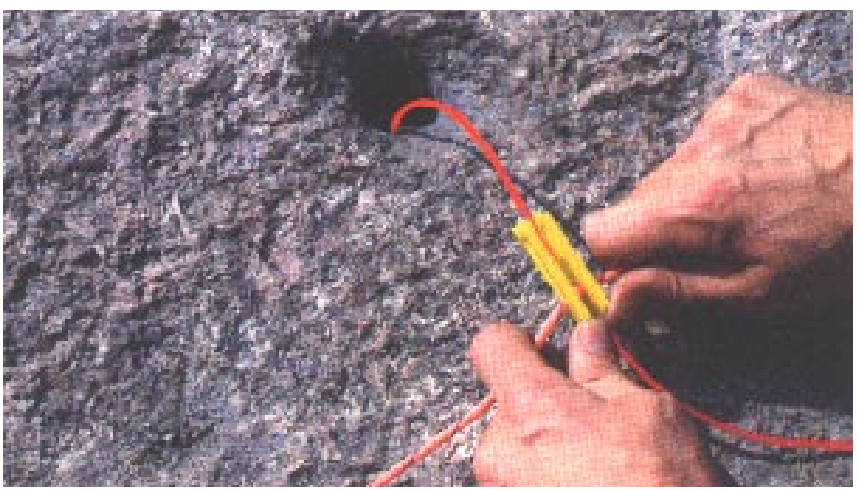


In this case each Ɛclip initiates 6 blasthole detonators and one connection block. For shortest possible delay of the surface initiation the initiation is made from a trunk line.

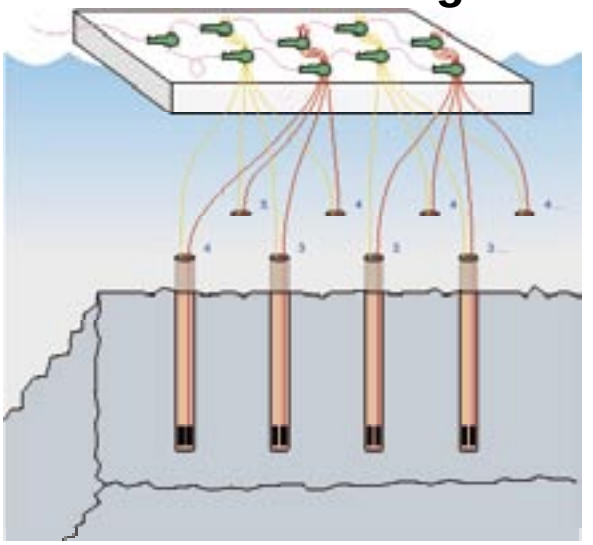
Initiation with detonating cord



Rounds with NONEL MS can be initiated with detonating cord if noise and air shock waves can be tolerated at the work site. Detonating cord with a core load of 5 g/m is recommended.
The NONEL tube is best connected to the cord by MULTICLIP.

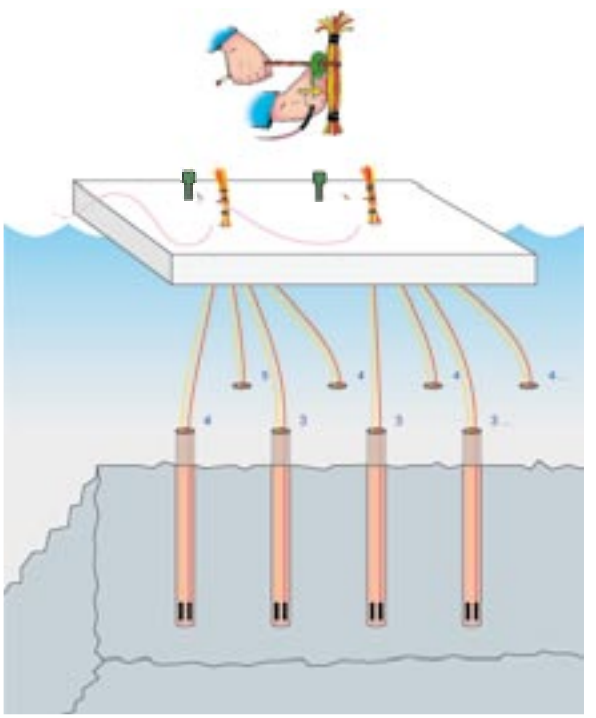


Underwater blasting



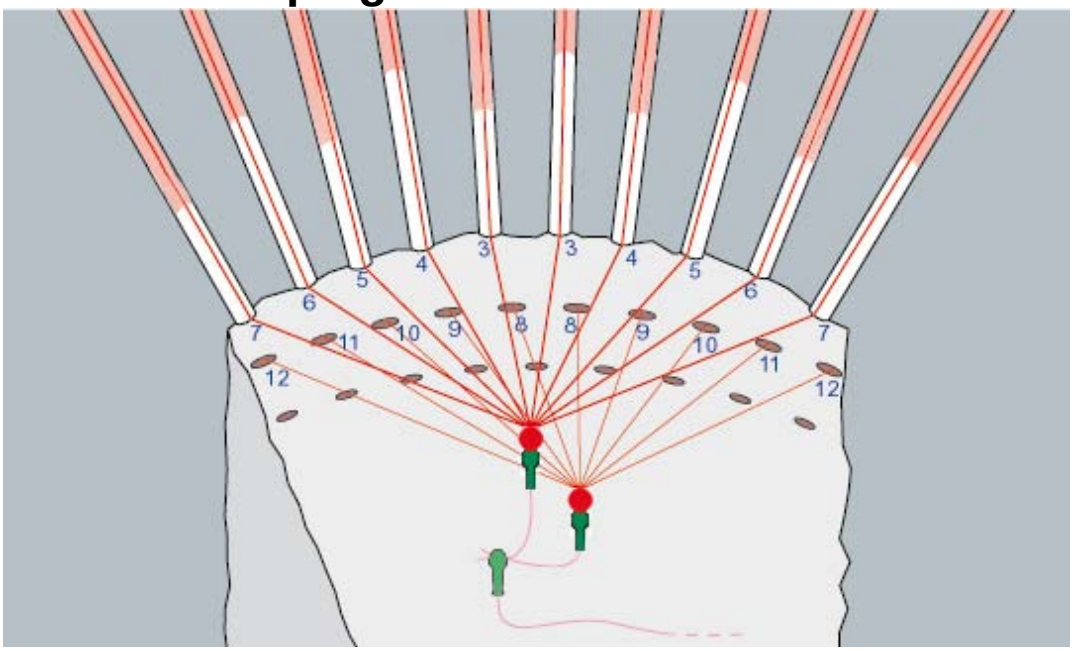
In underwater blasting using NONEL MS it is recommended that two detonators are used in each hole. The tubes from the detonators are connected to Ɛclip 0 above the water surface, preferrably on floats of polystyrene or similar.

To secure initiation in underwater blasting, the initiation should be done via 2 trunklines.



Underwater rounds may also be initiated by a 5 g/m detonating cord. A minimum of 5 to a maximum of 20 NONEL tubes are collected into a bunch and then taped together. The detonating cord is tied around the bunch with a clove hitch. Alternatively a bunch connector with SnapLine block can be used. See pages 35 and 37.
The bunches should have a distance of at least 0.5 m between each other to avoid the risk of cutoffs of tubes.

Sublevel stoping



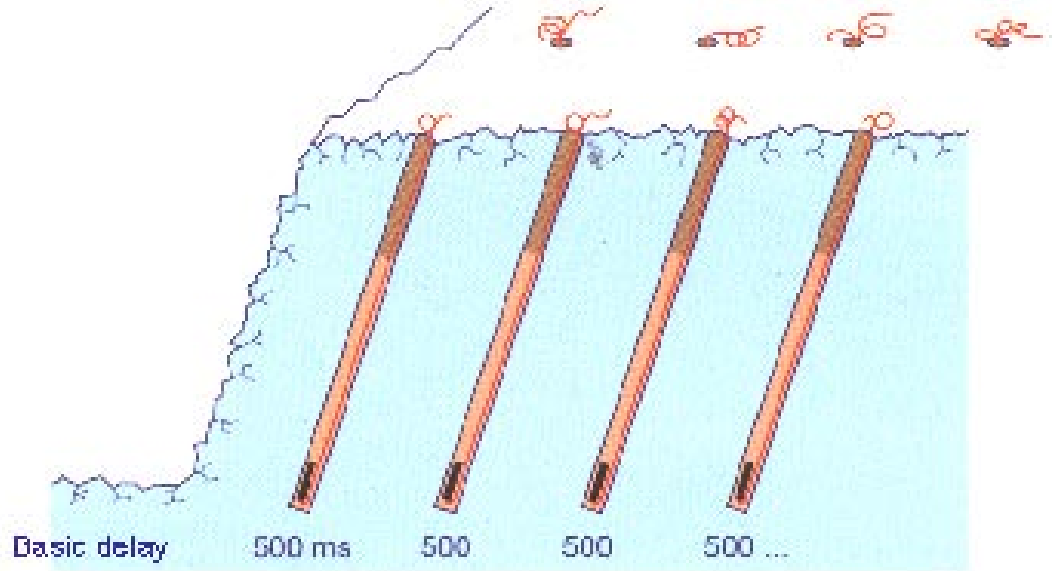
Sublevel stoping is a mining method where holes are drilled in a circle from a development drift and blasted towards a raise shaft or blasted rock. NONEL MS is well suited for sublevel stoping which is kind of upside down bench blasting.

NONEL UNIDET

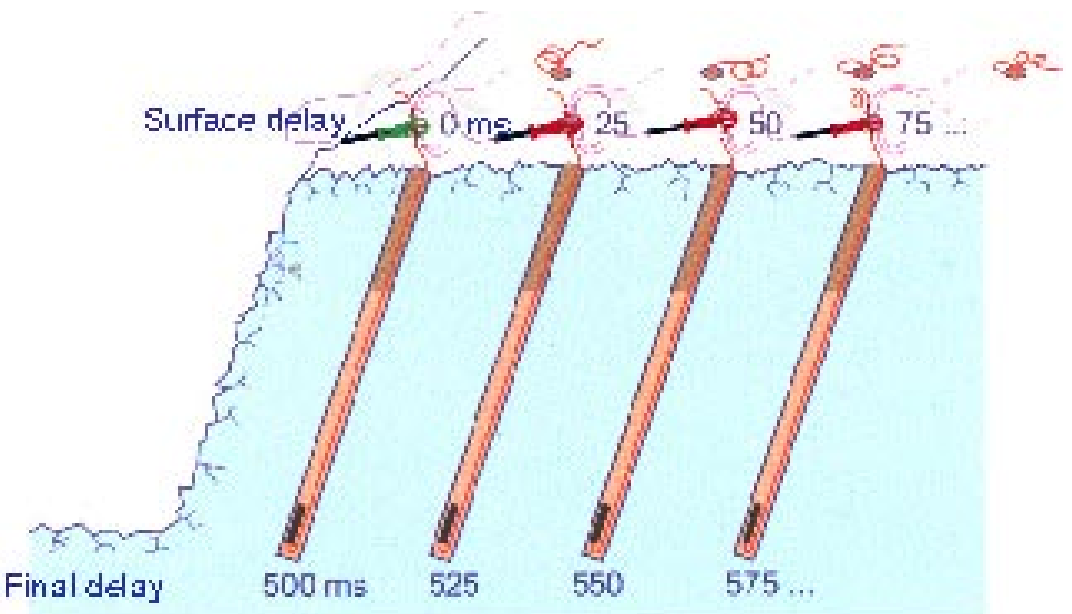
The NONEL UNIDET system is based on an inhole detonator with uniform delay times. All inhole detonators in the round have the same delay time and the firing sequence is built up on the surface with connection units with their own inbuilt delays. The delay time of the inhole detonators is normally chosen to be 500 ms which gives time enough for surface activation of all inhole detonators before any rock movement starts.

Dyno Nobel's recommendation is to use 2 detonators in each charge when the hole depth is over 10 m or when the rock is fissured or water saturated. When the holes are fissured, it is common that the explosives string separates and then it is necessary to have one detonator in the bottom of the hole and another in the top part of the hole. The delay time of the bottom detonator should be shorter than that of the top detonator to avoid top initiation.

NONEL UNIDET - Principal of initiation



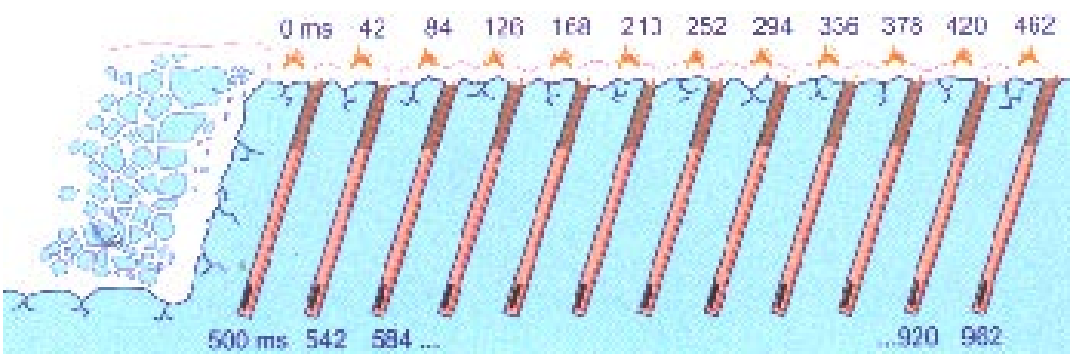
All the holes in the round are normally loaded with detonators with the same delay time. In this case 500 ms.



The firing sequence is determined on the surface with Ɛclip connection blocks.

Ɛclips are available with different delay times, they are color coded, each color indicating the delay time.

Green	0 ms (nominal 2 ms)
Yellow	17 ms
Red	25 ms
White	42 ms
Blue	67 ms
Black	109 ms
Orange	176 ms
Brown	285 ms



Surface activation is completed before any rock movement starts.

Risk of overlapping. Maximum size of rounds for different initiation patterns when using NONEL UNIDET.

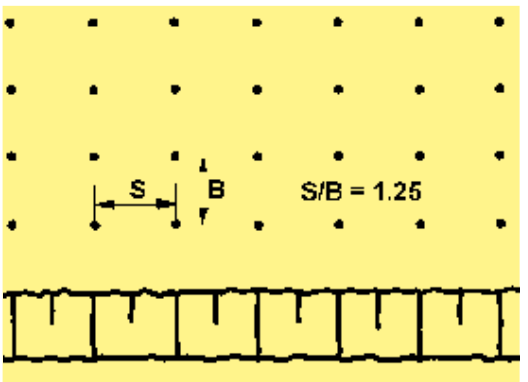
According to Swedish Standard SS 499 07 07 “Initiation system with non-electric shock tube of low energy type” section 19.4 “theoretical verification” the maximum size of rounds for different initiation patterns should be specified. If the specified number of holes is exceeded there is a risk of overlapping according to the Swedish Standard.
We advise against firing patterns that do not meet the demands of the Swedish Standard.
The calculations are based on nominal delay times given by the manufacturer and the maximum standard deviations and shall show when there is a risk of overlapping in the most unfavorable case.
Overlapping means that a hole in the row behind detonates before a hole directly in front of it.
The risk of overlapping is stated for each initiation pattern.
The recommendations given are valid under the condition that all in-hole detonators have the same active tube length. Active tube length means the length of tube that is between the in-hole detonator and the point where the surface connection unit is connected.
The additional time, due to the shock wave velocity in the tube, adds to the delay time and adversely affects the number of holes in a row when the active tube length decreases with the length of the round, i.e. when the active length of the tube is shorter in one row than in the row in front. For this reason the greatest permitted difference in length is 5 m.

Differences in length from 0 to 5 m have been taken into account have been taken into account when computing the risks of overlapping.

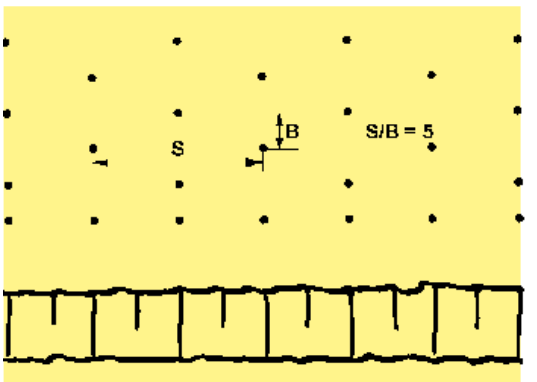
NOTE! The delay times between the rows must always be longer than the delay times between the holes in the rows.

Wide-space effect.

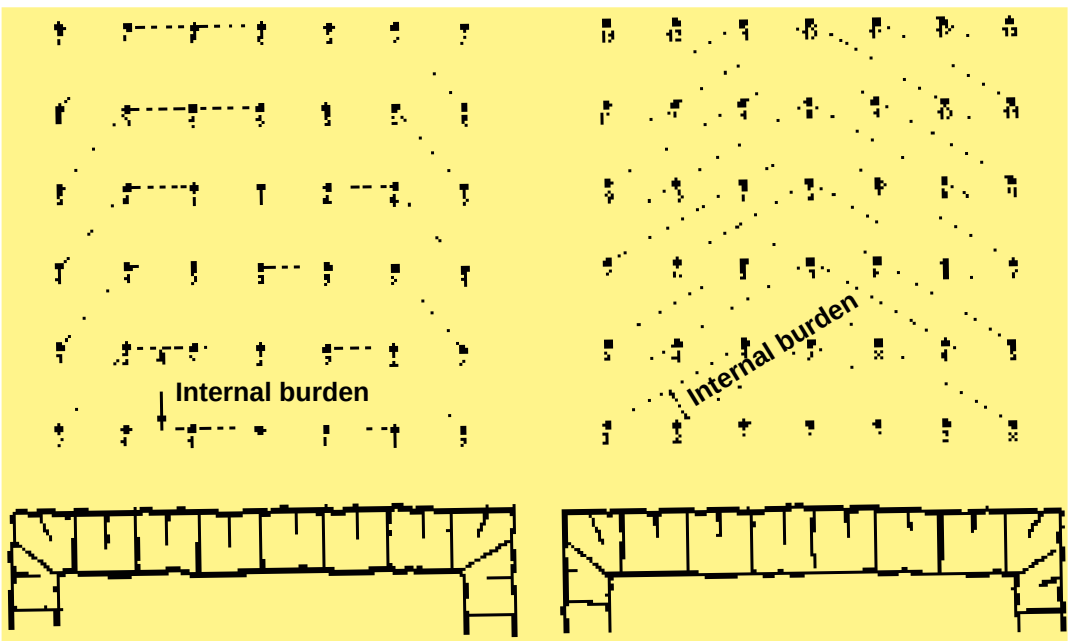
The typical drilling pattern has a spacing/burden ratio of 1.25, which has proved to give good rock fragmentation in multiple row blasting. In the 70s, tests were carried out in Sweden with wide-space hole blasting with S/B ratios greater than 1.25. The results of the tests showed improved fragmentation up to an S/B ratio of 8. The burden and spacing must be normal in the first row, otherwise the burden will be too small increasing the risk of flyrock.



Typical drilling pattern

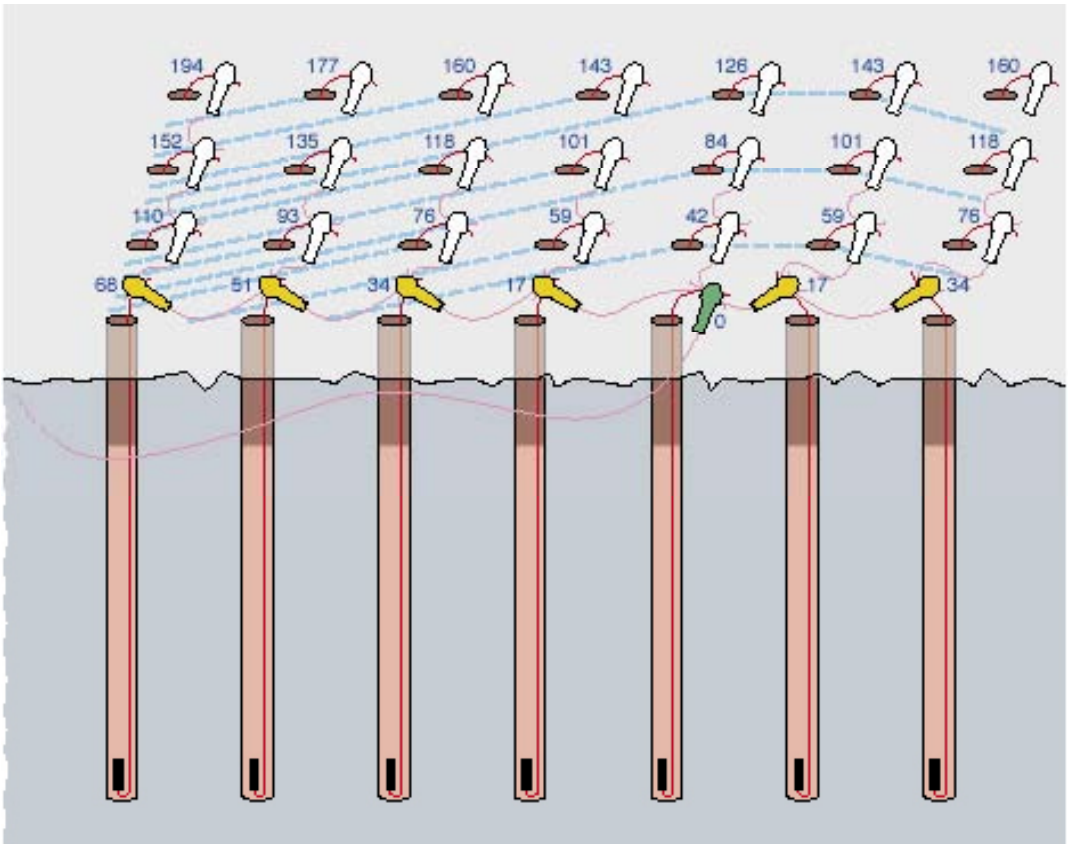


Wide-space drilling pattern



By changing the firing pattern instead of the drilling pattern the same wide-space effect is accomplished. This is easy with NONEL UNIDET and its combination of connection units with different delay times.

Firing pattern UNIDET 1 - Plowformed initiation

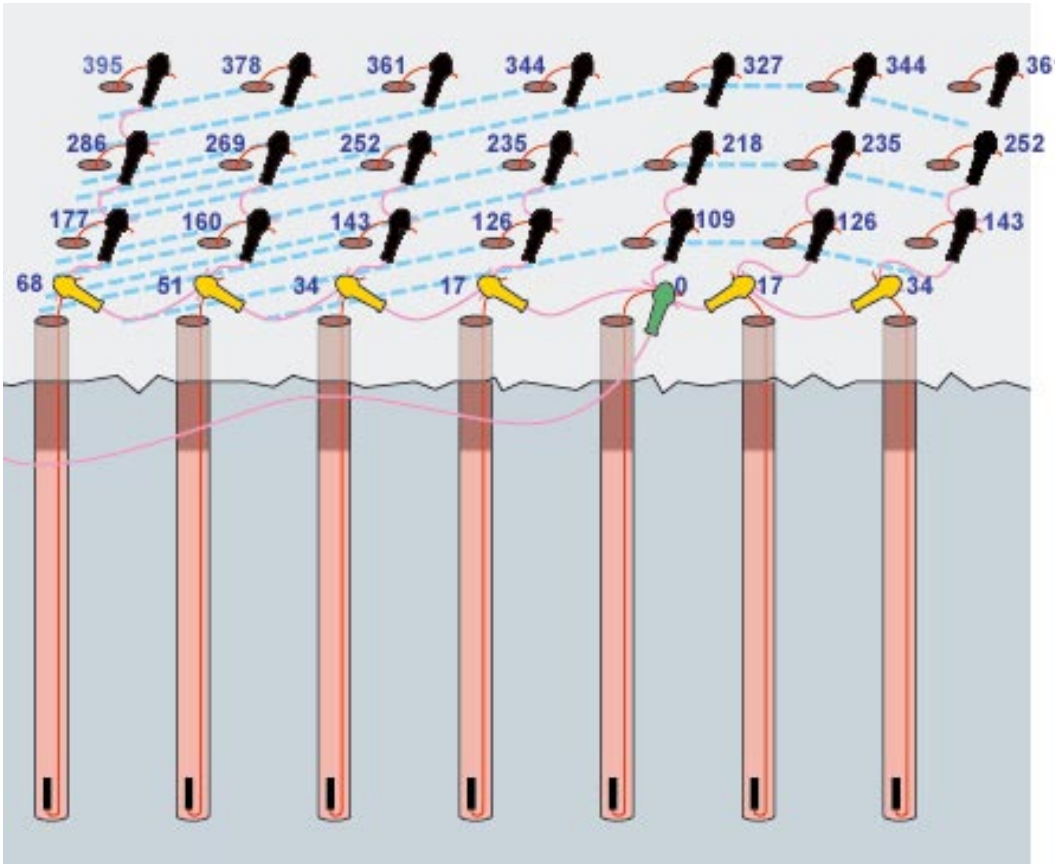


Firing pattern with 42 ms delay between the rows and 17 ms between the holes in the rows. Plowformed initiation gives good wide-space blasting effect.

Risk of overlapping:

Ɛclip 17 should not be used between rows. Then the risk of overlapping is greater than that stated in Swedish Standard. In all other combinations where the delay time between holes in the rows is shorter than the delay times between the rows the overlapping risk does not exceed the demands stated in Swedish Standard.

Firing pattern UNIDET 2 - Large burden and large diameter holes

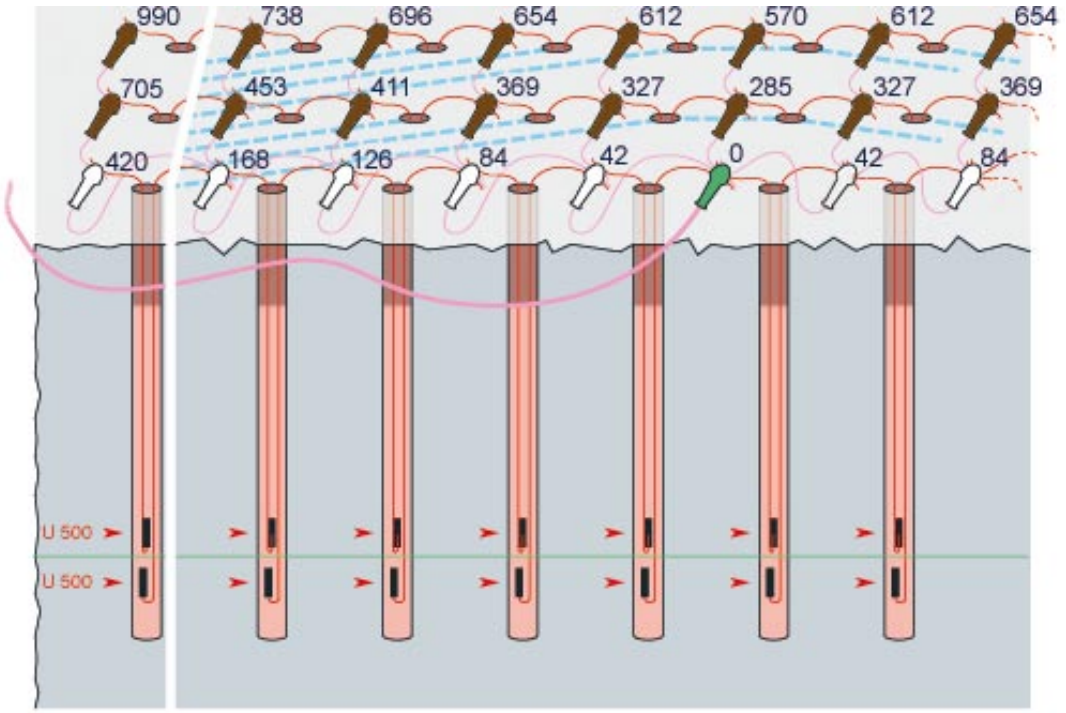


Firing pattern with 109 ms delay time between the rows and 17 ms between holes in the row. Suitable for rounds with relatively large diameter holes and thus large burdens. The holes are connected directly to the hole in the row in front.

Risk of overlapping:

Ɛclip 17 should not be used between rows. Then the risk of overlapping is greater than that stated in Swedish Standard. In all other combinations where the delay time between holes in the rows is shorter than the delay times between the rows the overlapping risk does not exceed the demands stated in Swedish Standard.

Firing pattern UNIDET 3 - Very large burden and large diameter holes.

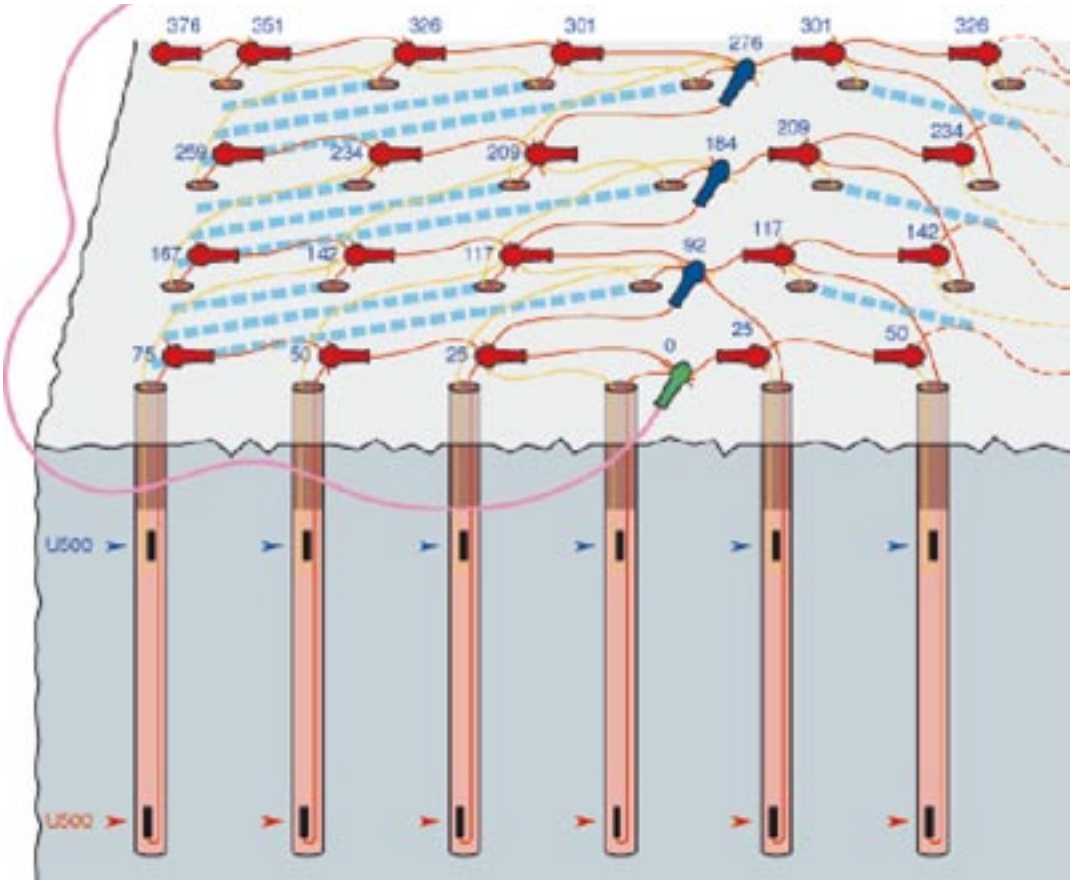


Firing pattern with 285 ms delay time between the rows and 42 ms between the holes in the rows. This gives a wide-space blasting effect. Each hole has 2 detonators giving back up initiation by connecting each detonator different connection blocks.

Risk of overlapping:

Ɛclip 17 should not be used between rows. Then the risk of overlapping is greater than that stated in Swedish Standard. In all other combinations where the delay time between holes in the rows is shorter than the delay times between the rows the overlapping risk does not exceed the demands stated in Swedish Standard.

Firing pattern UNIDET 4 - Top and bottom initation



U 500 detonators are used both in top and bottom of the hole. The top detonator is delayed in relation to the bottom detonator by connecting it to a connecting block in the next row. In this case the top detonator is delayed 67 ms in relation to the bottom detonator. This is to avoid top initiation as far as possible.

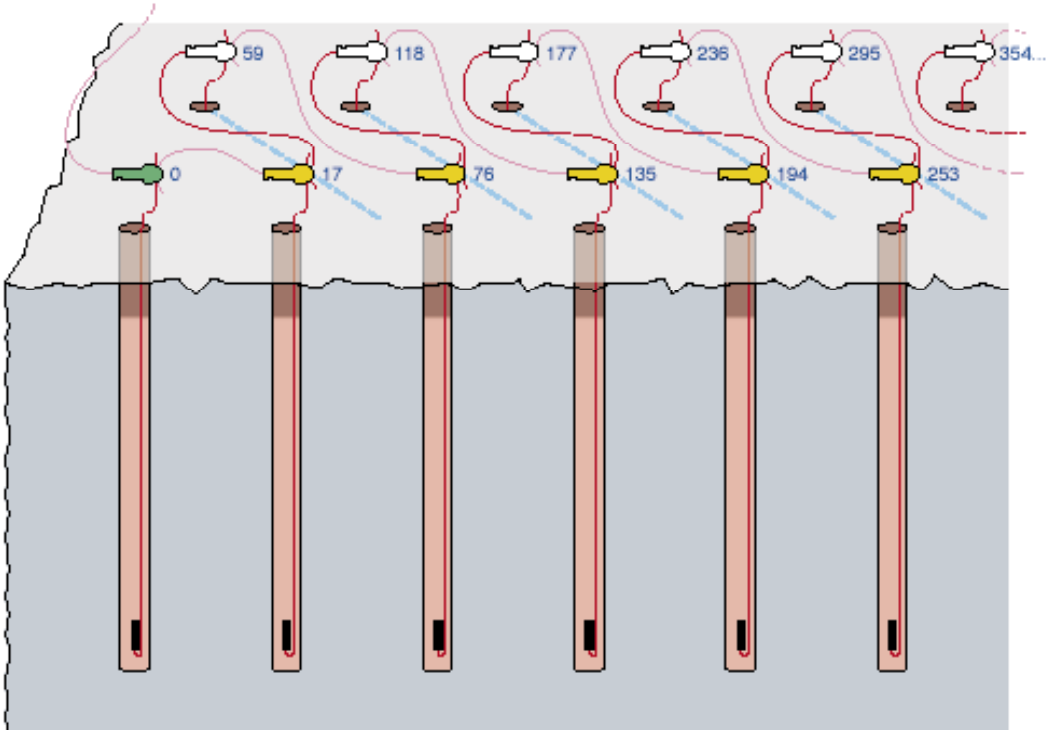
To distinguish which detonator is in the top and which is in the bottom, the top detonator has yellow tube and the bottom detonator red tube.

The firing pattern is suitable when the rock is fissured and when bulk explosives are used.

Risk of overlapping:

An unlimited number of rows and holes in the rows may be connected without exceeding the demands stated in Swedish Standard for overlapping.

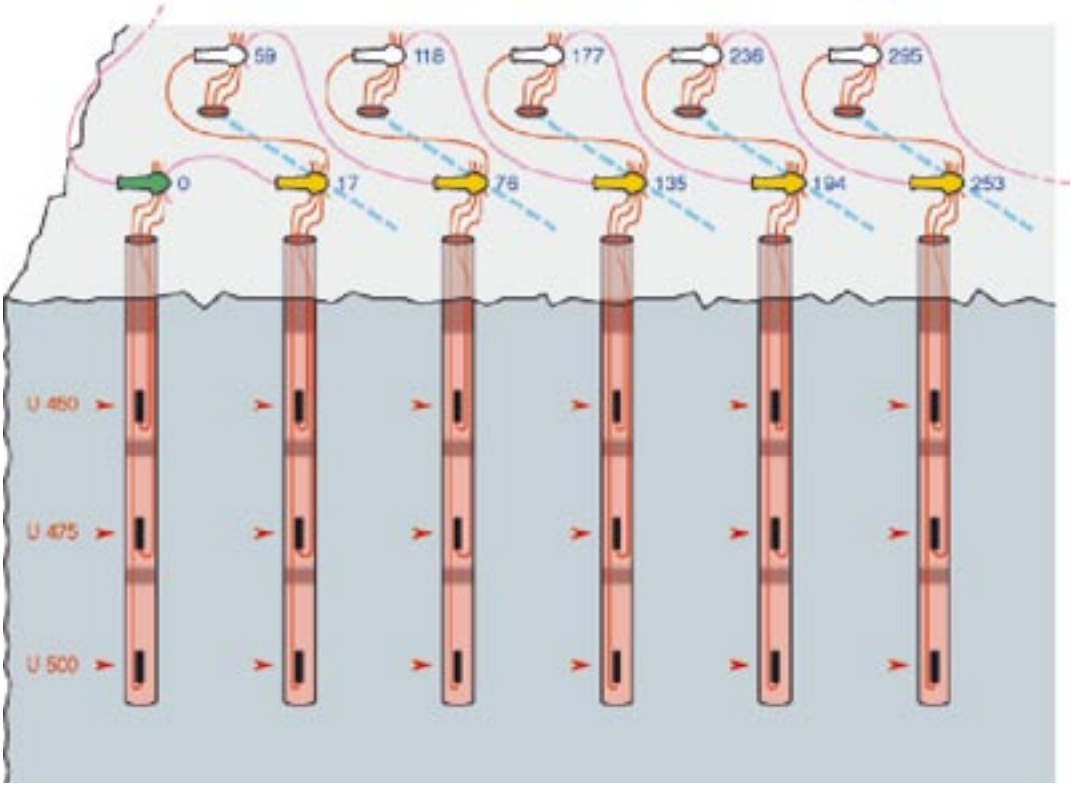
Firing pattern UNIDET 5 - Zig-Zag connection



Simple zig-zag connection with 101 ms delay between the rows and 59 ms between the holes in the rows. However, in the beginning of the connection the delay times are shorter, 59 ms respective 17 ms. This firing pattern is suitable for firing a simple 2 row blast.

Risk of overlapping:
No risk of overlapping.

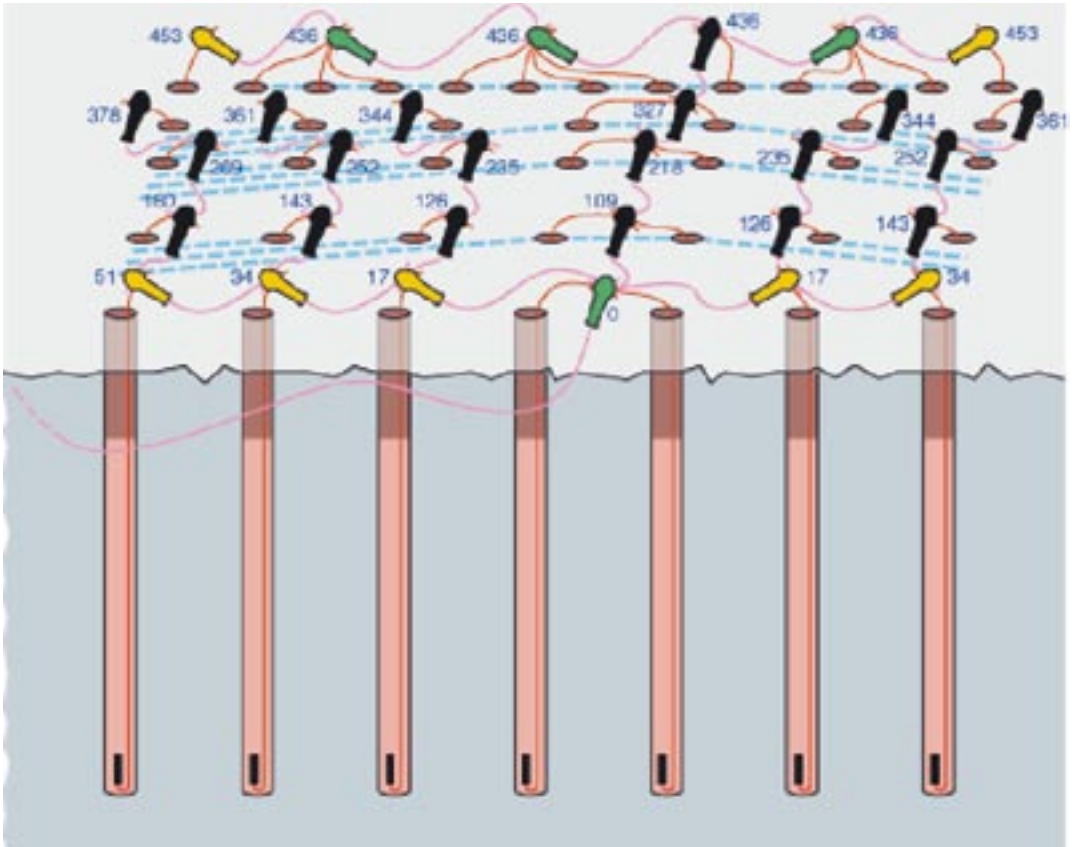
Firing pattern UNIDET 6 - Deck charging to control ground vibration



Three-piece charging for blast sites with ground vibration problems. Each portion of the charge gets its own delay time as in-hole detonators with 450, 475 and 500 ms delay are used. 101 ms delay between the rows and 59 ms between the holes in the rows. (Except hole 1and 2 in the first row.)

Risk of overlapping:
No risk of overlapping.

Firing pattern UNIDET 7 - Smooth blasting



Smooth blasting with NONEL UNIDET. The smoothblasting row is connected in such way that it fires last.

Risk of overlapping.

0 m difference in active tube length

Number of holes that may be connected without exceeding the demands in the Swedish Standard:

Number of rows	*4*	*11*	*16*
Maximum number of holes per row:	*14*	*12*	*10*

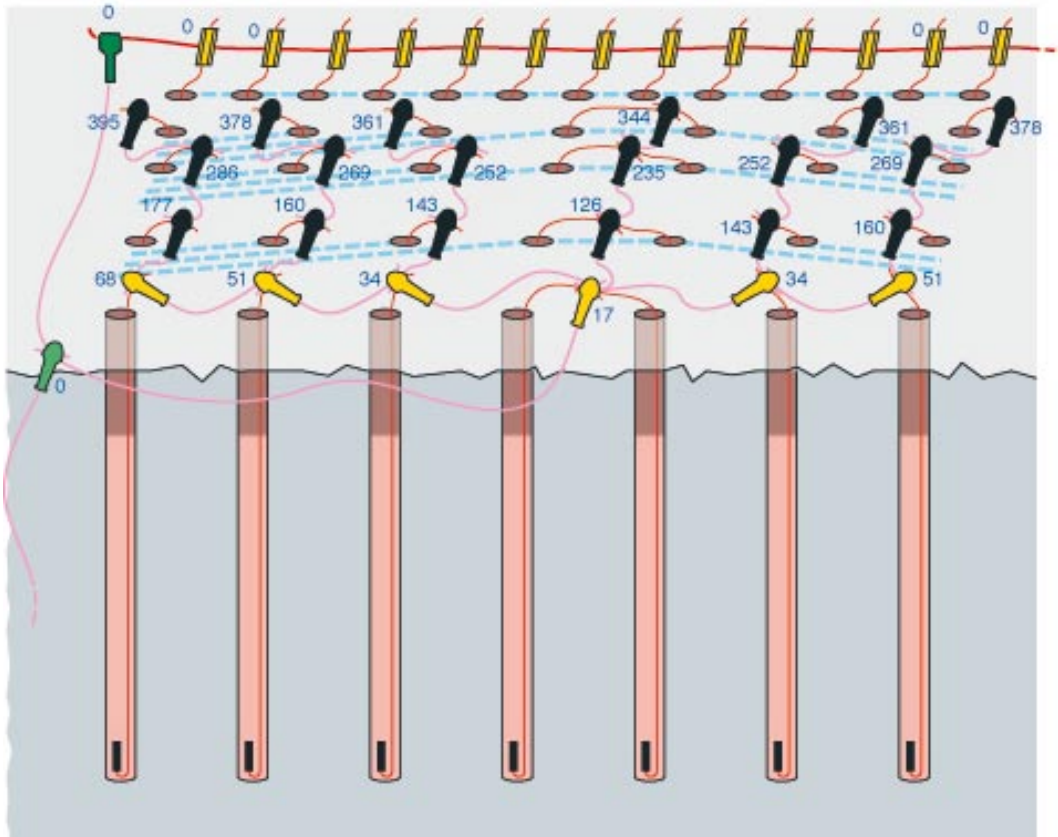
5 m diffeerence in active tubelength

Number of holes that may be connected without exceeding the demands in the Swedish Standard:

Number of rows	*3*	*10*	*15*
Maximum number of holes per row:	*14*	*12*	*10*

Symmetric connection is assumed for the above values, that is connection starts in the middle and outwards in both directions.

Firing pattern UNIDET 8 - Presplitting



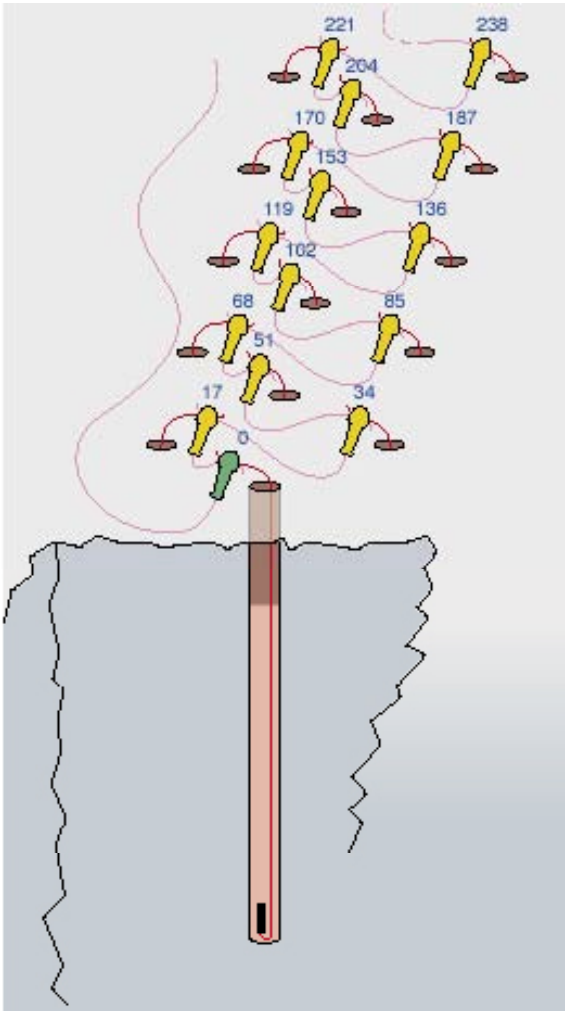
Presplitting with NONEL UNIDET. The best result is obtained if detonating cord (5.0 g/m) is used to initiate the presplitting row (Be aware that the detonating cord can give an enhanced air over-pressure reading).
The detonating cord must be at least 20 cm away from the NONEL tubes to avoid cut offs.

Note! A Snapline 0 is needed to initiate the presplitting row.

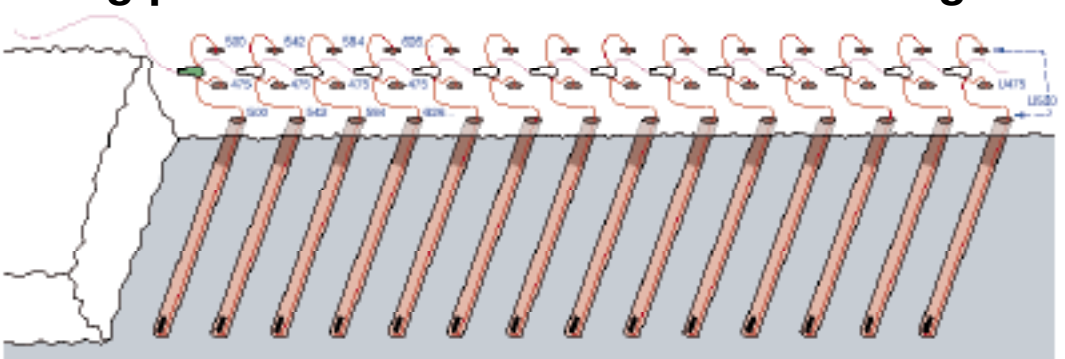
Risk of overlapping:
No limitations in round, however the presplit row will be initiated first.

Firing pattern UNIDET 9 - Trench blasting

Simple connection for a pipeline trench; only 3 components, which can be reduced to 2 if Ɛclip 0 is replaced by Ɛclip 17.



Firing pattern UNIDET 10 - Trench blasting

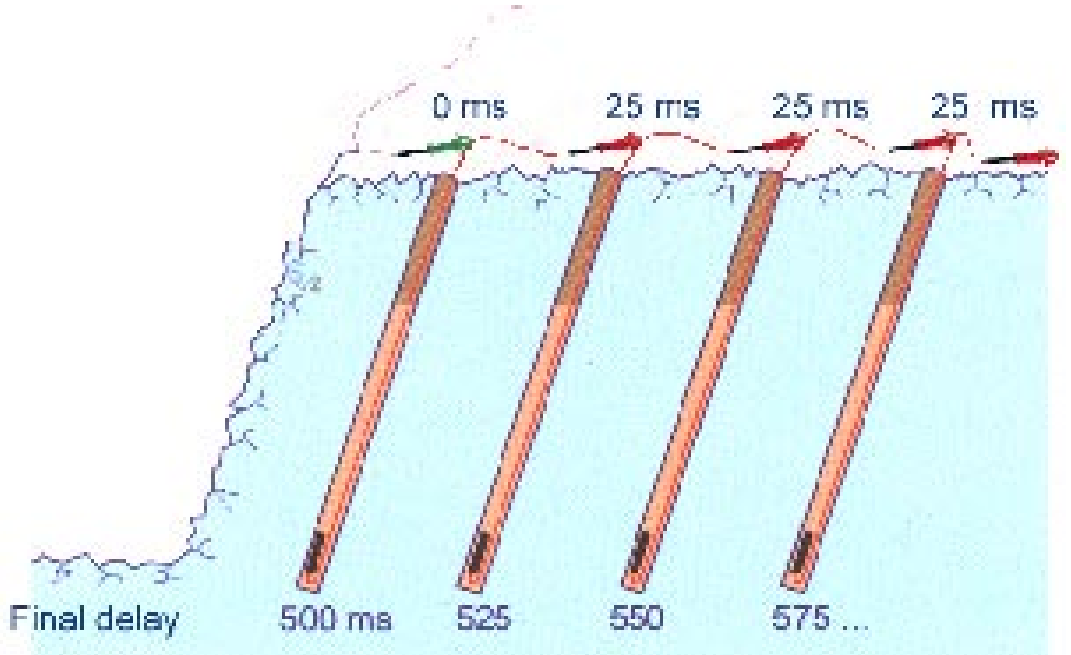


Trench blasting with U475 in the middle holes and U500 in the edge holes. 42 ms delay between the rows gives good breakage geometry in the round.

NONEL SnapDet

NONEL SnapDet is a combination detonator which consists of an in-hole detonator on one end of the tube and a surface connection block on the other.
NONEL SnapDet complements the NONEL UNIDET-system and simplifies the connection work without forgoing the possibility to give each particular blasthole its individual initiation time.
Each hole in the round has the same type of NONEL SnapDet detonators. The delay beween the rows is obtained with SnapDet's surface connection unit. Connection and delay between the rows is made with NONEL UNIDET Ɛclip.
The round is fired conventionally.
One advantage with NONEL SnapDet is that stock keeping may be kept at a minimum level. Only one kind of SnapDet and one kind of Ɛclip is required to carry out most blasts.
In order to fully exploit the system´s range of possibilities, the worksite should have a standardized workcycle with recurrent drilling, charging and firing patterns. Such work sites are quarries, open pit mines and large construction sites.

Note of safety! As the surface connector is connected to an in-hole detonator it is of utmost importance that the surface connector is not subjected to impact or squeezing during the charging operation.
Such risk may be movement of equiment on the bench.



Principle of connection for NONEL SnapDet

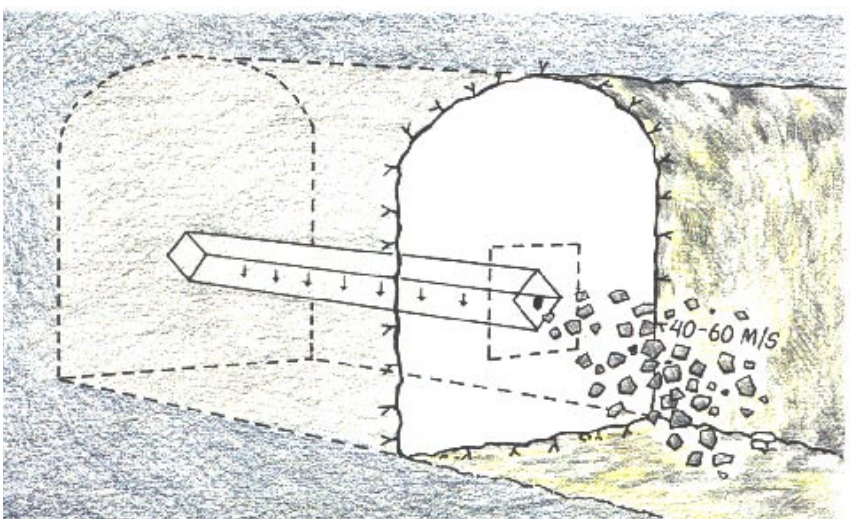
Standard range of products NONEL SnapDet.

Denomination	Surface connection unit Delay time, ms	Surface connection unit Color	In-hole detonator Delay time, ms
SnapDet 0/500	2	Green	500
SnapDet 17/500	17	Yellow	500
SnapDet 25/500	25	Red	500
SnapDet 42/500	42	White	500
SnapDet 67/500	67	Blue	500
SnapDet 109/500	109	Black	500
SnapDet 176/500	176	Orange	500
SnapDet 285/500	285	Brown	500

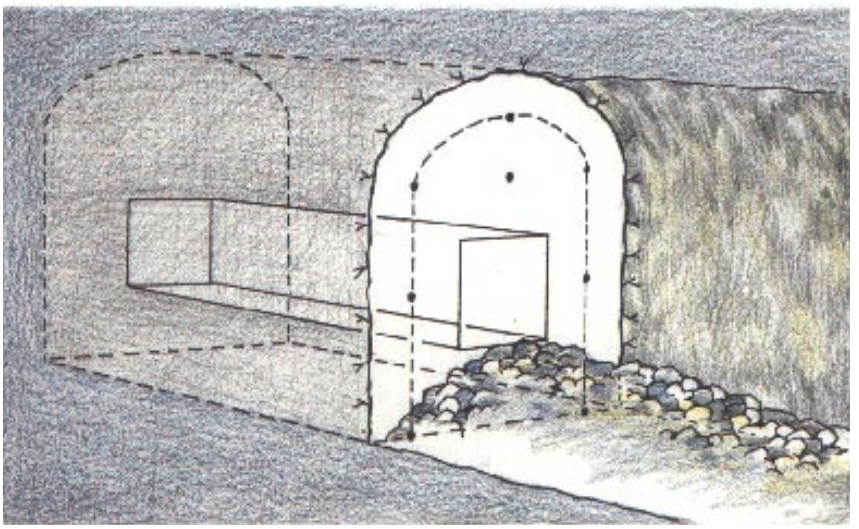
The in-hole detonator may also be furnished with 400, 425, 450 or 475 ms delay.

NONEL LP

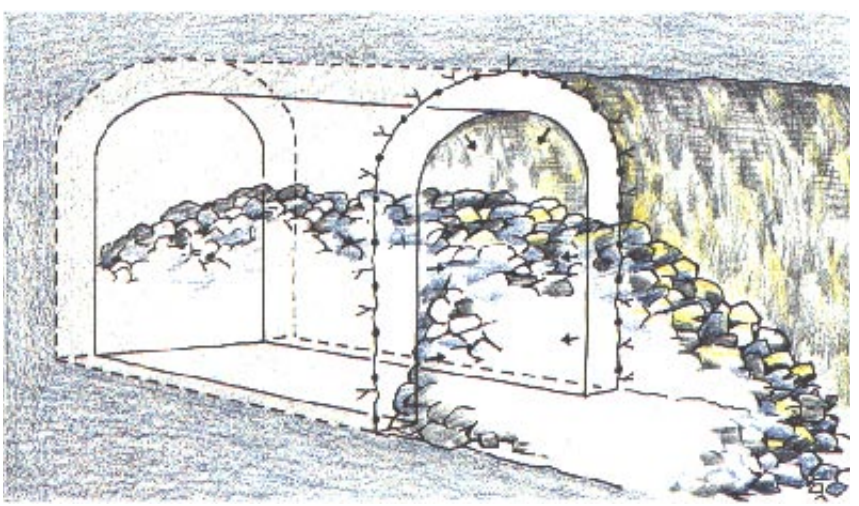
NONEL LP has been developed for drift and tunnel blasting where there is a need for longer delay times to give the rock time enough to allow for breakage of the rock and for it to be thrown out from the front. Most of the tunnels are nowadays blasted with a parallel hole cut with one or more large holes. The blasted rock from the holes close to the large hole/s must be given time to break and move out of the large hole/s before next hole detonates. The rock mass moves towards the front with a velocity of 40 to 60 m/sec. With a hole depth of 4 m it takes between 60 and 100 ms before the broken rock has left the large hole/s. A delay time of 100 ms between the period numbers is thus necessary to avoid freezing of the cut area with the consequent bad blasting result.



In the stoping area another effect by the explosive and the detonators is sought for. When the cut is blasted and thrown from the face, room has been made for the rock masses from the stoping area where a limited forward throw is desired. Therefore the delay times are longer between the period numbers in the stoping area giving a short, not scattered muckpile which is easy to load. The delay time between period number in the stoping area is 500 ms.



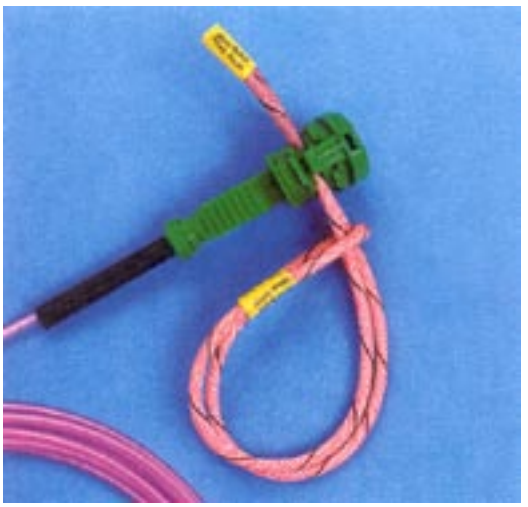
For the blasting of the contour, the first demand is that the detonators have high precision so the contour holes cooperate in the smoothblasting.



The LP-series have the following nominal delay times:

# 0	25ms	# 7	700 ms	# 16	1600 ms	# 45	4500 ms
1	100 ms	8	800 ms	18	1800 ms	50	5000 ms
2	200 ms	9	900 ms	20	2075 ms	55	5500 ms
3	300 ms	10	1000 ms	25	2500 ms	60	6000 ms
4	400 ms	11	1110 ms	30	3000 ms		
5	500 ms	12	1235 ms	35	3500 ms		
6	600 ms	14	1400 ms	40	4000 ms		

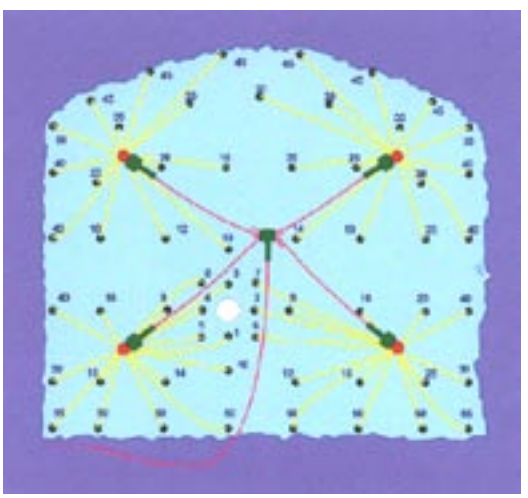
Bunch Connector

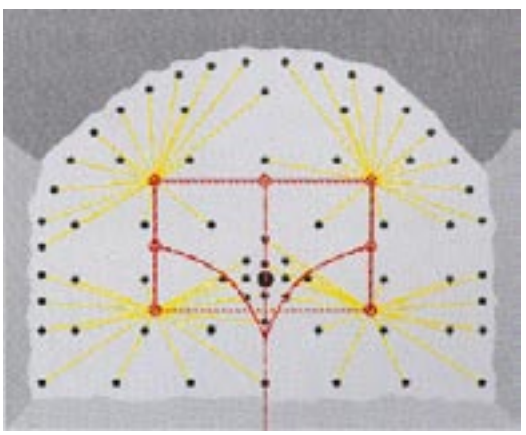


The simplest way to hook up a NONEL LP blast is by using bunch connectors. The bunch connector is a connector unit that is used to initiate a number of NONEL-tubes that have been gathered into a bunch. The technique is used primarly in tunnel blasting.

A bunch connector consists of a connector block which contains a zero delay detonator (SnapLine 0). In the connector block there is a loop of detonating cord (5 g/m). A bunch connector is designed for the reliable initiation of a maximum of 20 NONEL-tubes.

The number of tubes in a bunch should not be less than 5.





Initiation with detonating cord.

Instead of using bunch connectors, a loop of detonating cord may be used to connect the bunches. The detonating cord is fastened around the bunch with a clove hitch and extended to the next bunch until all bunches are connected to the detonating cord sling.

The method calls for precision and caution in the conncetion work as the shockwave from the detonating cord my cut adjacent NONEL-tubes without initiating them.

Therefore the sling of detonating cord is pulled from the front and streched up so adjacent NONEL-tube are at least 20 cm away from the detonating cord.

Detonating cord with a core load of 5 g/m is recommended. Higher core load increases the risk of cut-offs and subsequent misfires.

Initiation

Initiation with bunch connectors.

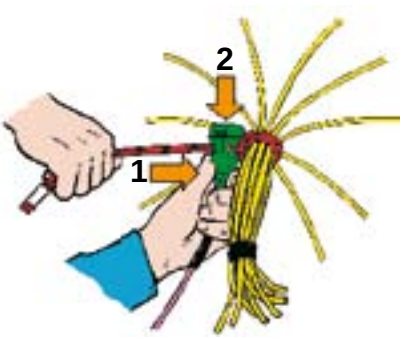
The bunch connector is only intended for use freely hanging on the tunnel face.

At least 5 and a maximum of 20 NONEL-tubes are collected into a bunch.

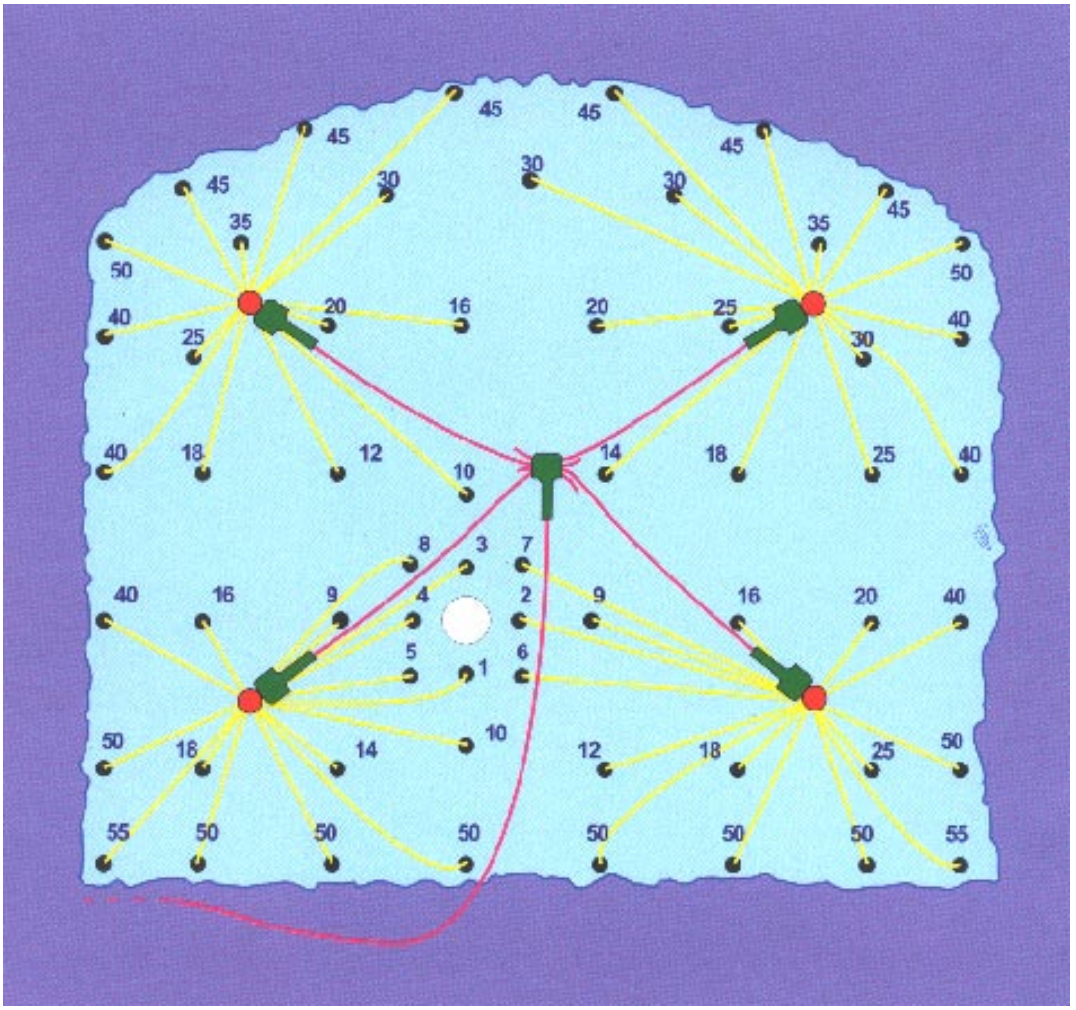
The bunch is taped approx. 50 cm from the front.

The bunch is passed through the loop of 5 g/m detonating cord. A Snapline 0 is fitted to the loop and slid towards the bunch.

Place the bunch connector approx. 10 cm from the tape. Press the SnapLine block towards the NONEL-bunch (1), Lock the bunch connector by pressing the lid to locking position (2). Connect the bunch connectors in an Ɛclip and pull the bunch connectors from the face. No bunch connector nor part of the detonating cord loop should be closer to an adjacent NONEL tube than 20 cm.



Firing pattern LP 1

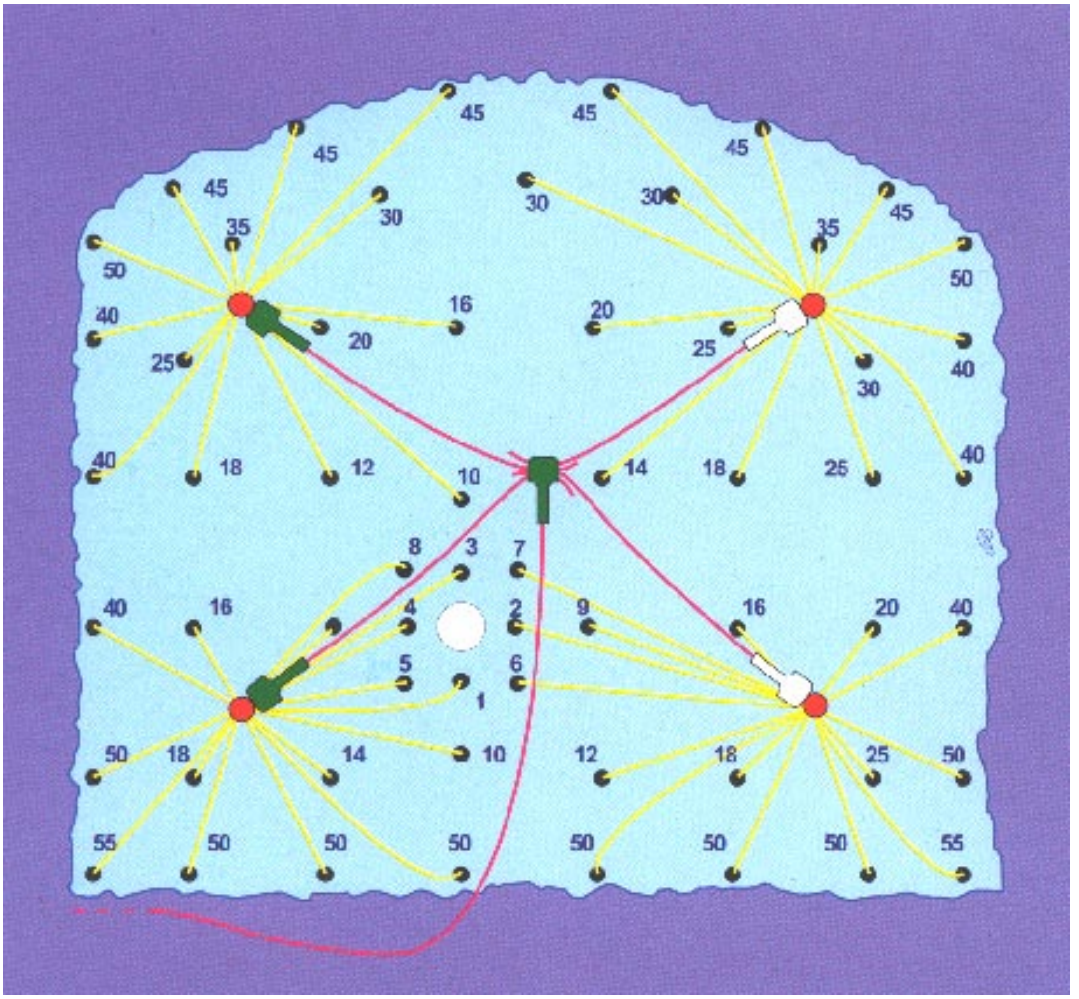


The round is charged conventionally with the lowest period number closest to the large empty hole and the highest in the contour holes. Initiation may be carried out using bunch connectors. Connect the NONEL tubes from bunch connectors to an Ɛclip 0 or a NONEL-Starter.

Note that LP 0 is not used. LP 0 could be useful to keep in in reserve if the large hole is filled with water. The the water can be blown out of it with a small charge that detonates first.

The difference in length of the tube between point of initiation and detonator should not exceed 5 m.

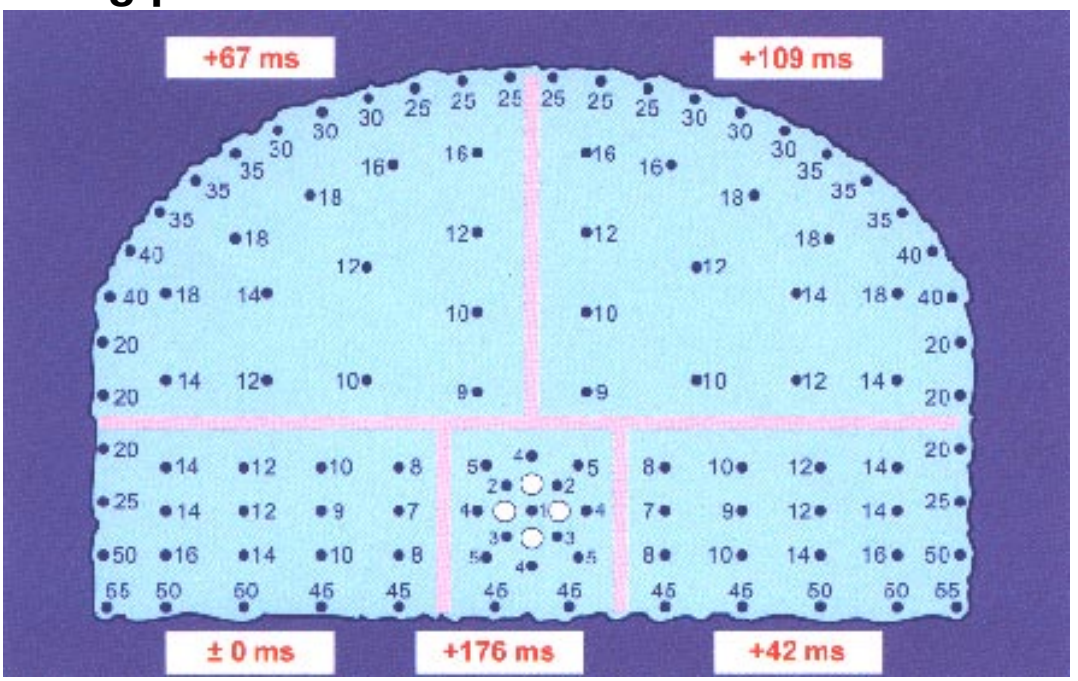
Firing pattern LP 2



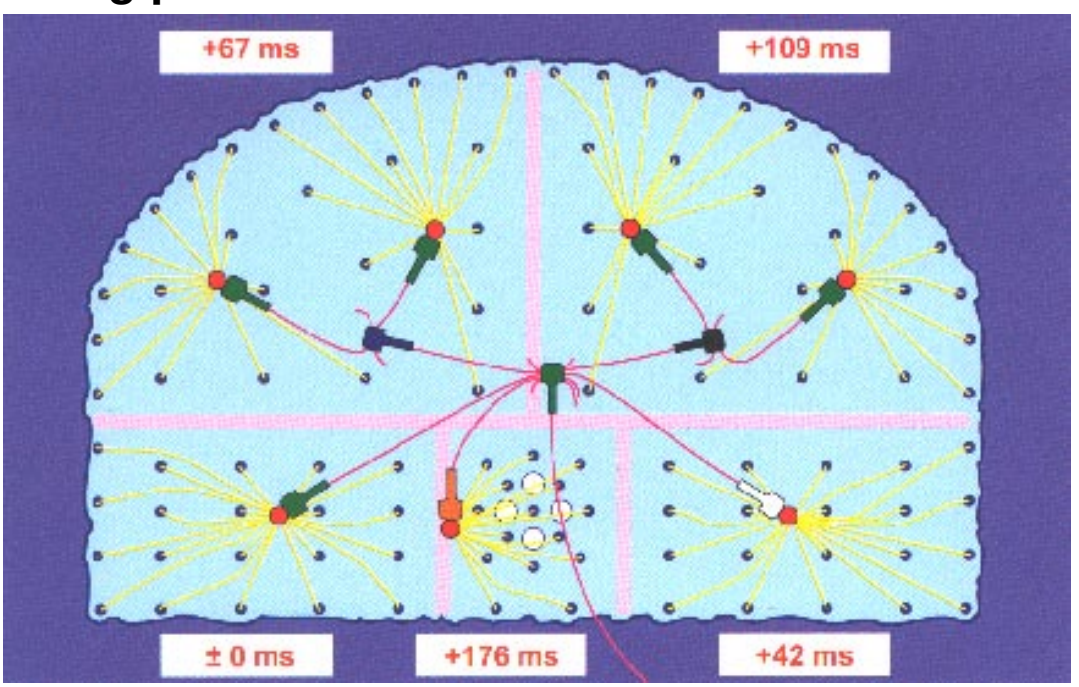
If there are vibration problems at the work site, it can be advantageous to delay half the round. As an example this diagram shows a 42 ms delay at the surface. This causes greater scatter and the risk of cooperation between charges decreases.

In this case it is not possible to use in-hole detonator LP 0 as a hole with that delay (25 ms) would detonate before the 42 ms connector has activated the in-hole detonators that are connected to these bunch connectors. The risk for cut-offs is obvious.

Firing pattern LP 3a

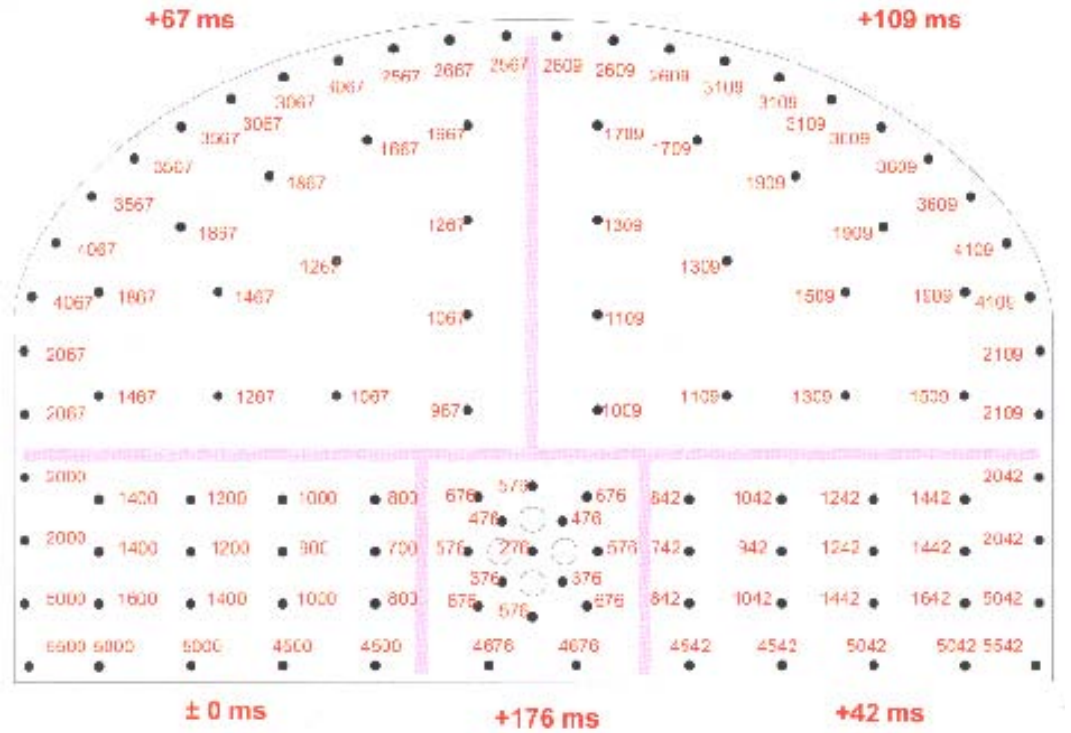


Firing pattern LP 3b



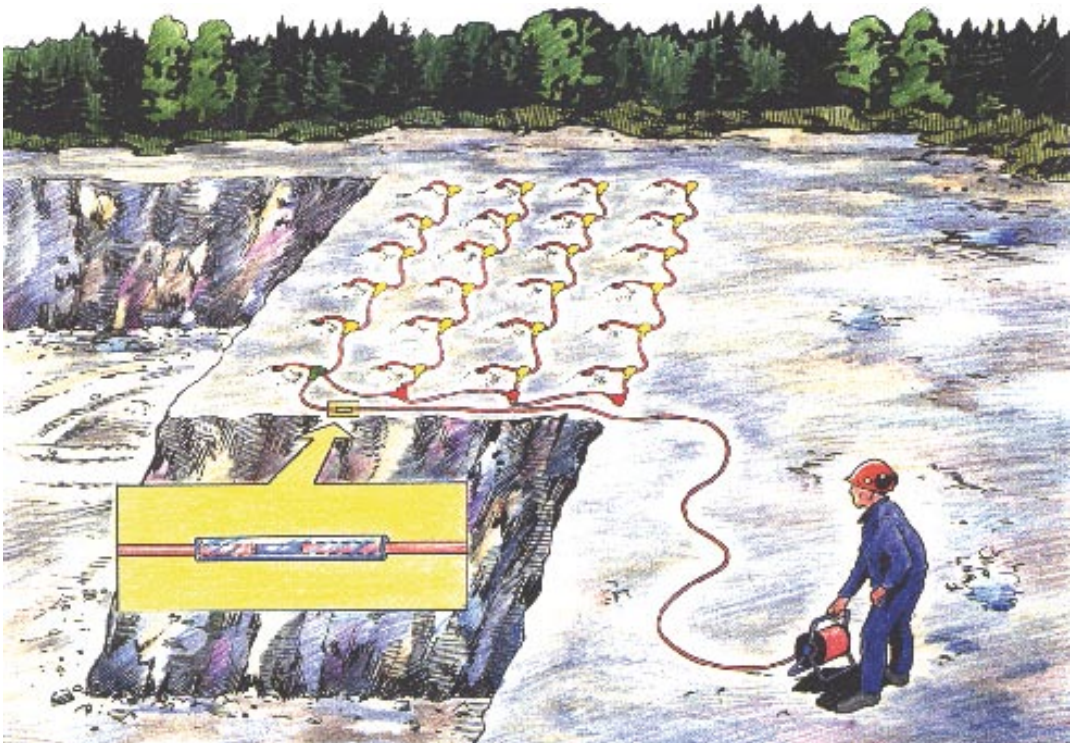
By using connectors with different delays it is possible to decrease the risk of co-operating charges in sensitive environments. In this case 5 different connector units been used to give more scatter in the delay times.
The shortest delay time in the cut is 100 ms (LP 1) to avoid cut-offs.

Firing pattern LP 3c



Real delay times for connection according to firing pattern LP 3b.

Initiation using DynoLine with a DynoStart



The simplest and safest way of initiating NONEL rounds is by using a DynoLine. DynoLine is NONEL tube on a bobbin of 750 or 1500 meter length that can be cut and connected to the Ɛclip connector that is used to initiate the round.

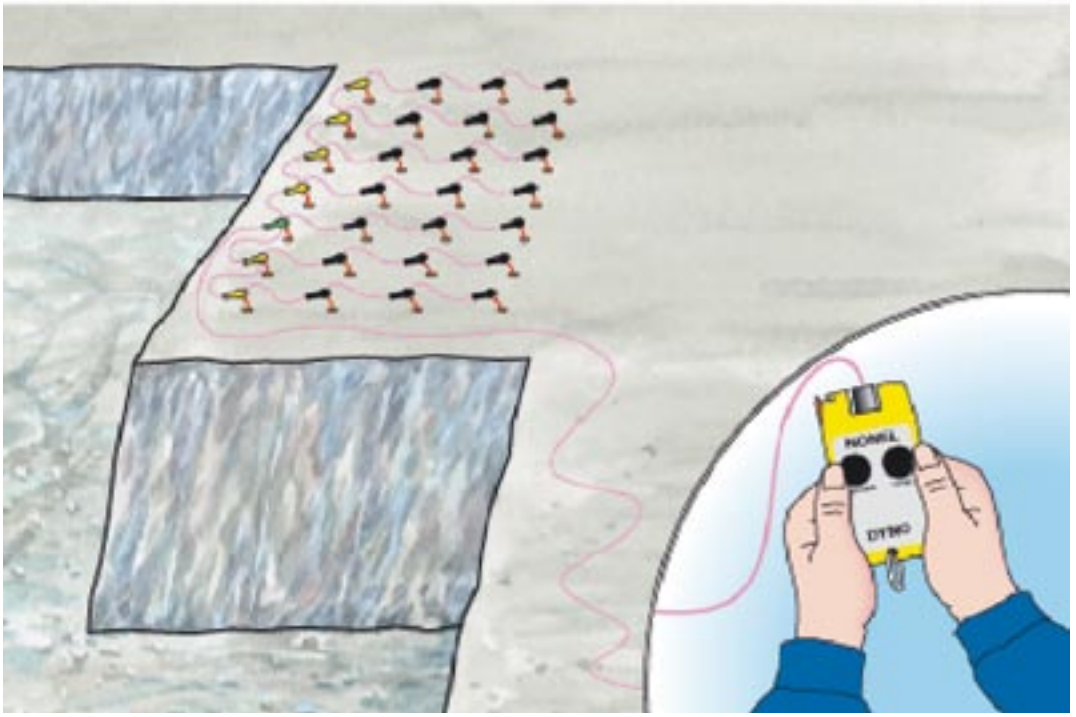
Cut off the ultra sonic seal at the end of the Ɛclip tube with a knife or the with the built-in cutting device on the DynoStart.

Then the tube is connected to DynoLine by means of an approx. 4 cm long outer tube that is cut from the transparent tube delivered with the DynoLine bobbin. The NONEL tube is pushed at least 1 cm into the outer tube. Then the DynoLine is extended to the chosen firing point.

When the round is ready to be blasted, connect the DynoLine to the blasting machine, DynoStart, by inserting the tube into the chuck as far as possible.

DynoLine is affected by humidity and the end of DynoLine must be sealed after each use. During connection under damp conditions care should be taken to avoid moisture entering the tube.

The DynoStart blasting machine is CE certified in accordance with the EMC directive.



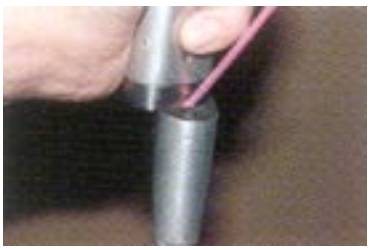
For initiation of the round, press the button “CHARGING” until the indicator LCD shines steady. Then the round is blasted by pressing the button “FIRING” at the same time as the button “CHARGING” is kept depressed. This causes a spark to be made inside the shock tube causing its initiation.

Initiation using Dynoline with HN 1

The HN 1 blasting machine is connected to the round via DynoLine. Cut away the end sealing of the tube.

Swing open the breech and tube holder in an anti-clockwise direction. Pass the NONEL tube upwards through the hole in the tube holder until it protrudes approx. 5 cm. Lock the tube in the retaining fork. Set the primer cap in the firing chamber.

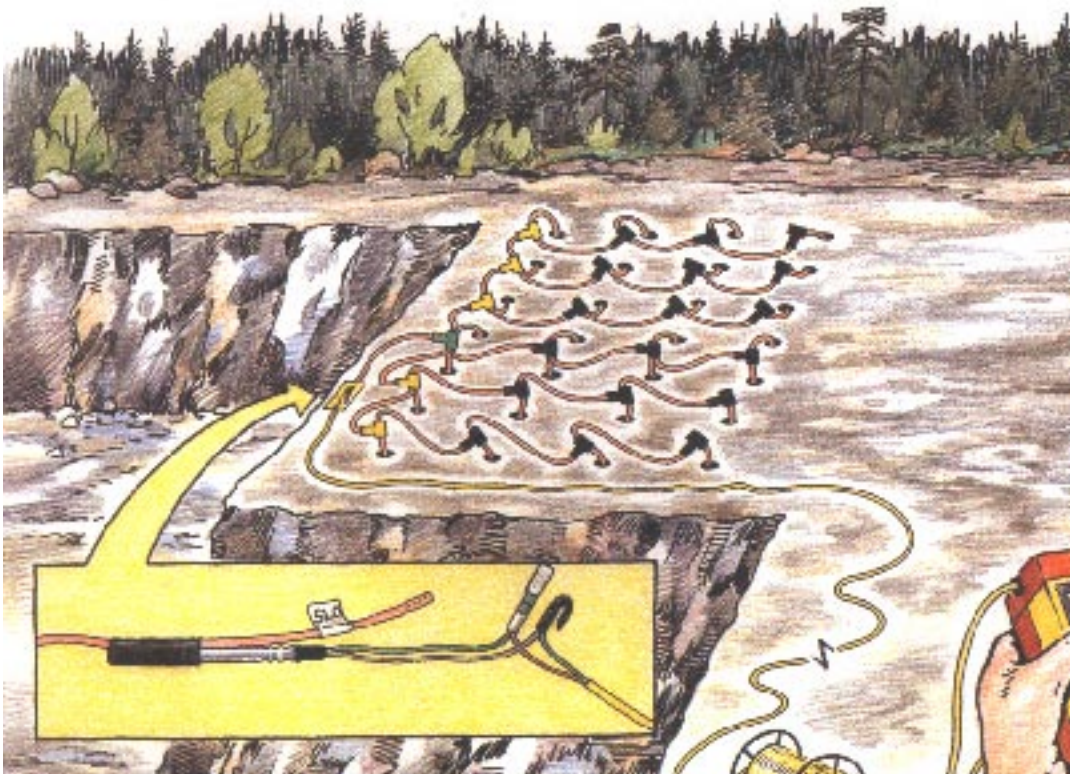
Close the breech against the stop pin. Close the tube holder to firing position. The NONEL tube is automatically cut to the correct length to suit the machine.



HN 1 is now ready for firing.

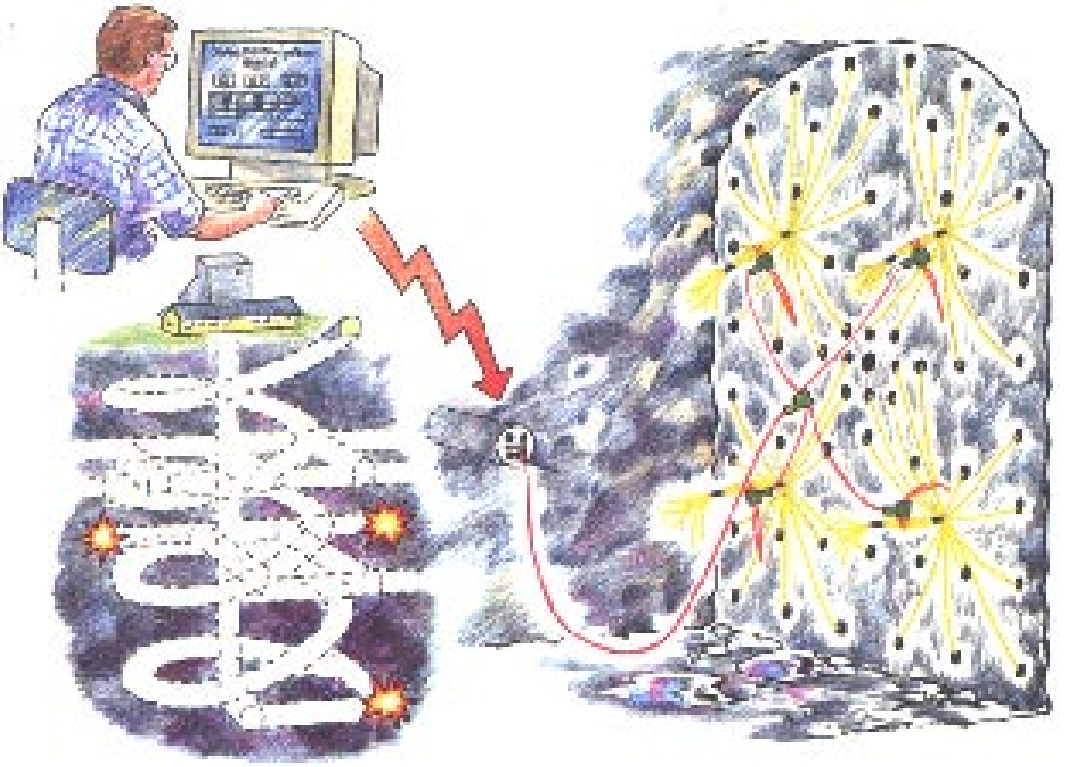
Press the safety catch and fire by driving the hand down on to the firing knob. The primer caps should be of the “Shotshell Primer No. 20” type, and are available from Dyno Nobel.

Initiation using electric detonator



NONEL rounds may also be initiated with an electric detonator. The electric detonator is then connected to the Ɛclip connector that is used to initiate the round. The electric detonator is taped to the NONEL with the detonator bottom pointing in the direction of the shock wave in the tube. The electric detonator should be well covered with earth, drill cuttings etc, as the strength of this detonator is considerably greater than that of an Ɛclip. Shrapnel from the detonator may cause cut-offs of the NONEL tubes in the round. Note that when the electric detonator is connected to the round the whole round is exposed to the same risks as when electric detonators are used in the round with regard to thunder-storms, static electricity, stray currents etc.

Remote controlled initation of underground rounds. DynoRem Mine.



DynoRem Mine is a remote controlled initation system for worksites underground which have an existing radio communication system. It consists of a computer controlled central unit and a maximum of 24 blasting machines.

The radio communication system of the worksite is used for communication between the central unit and the blasting machines. The central unit can be located in an office space above ground and the blasting machines close to each blasting site.

Each central unit may control up to 24 blasting machines that may be divided into groups containing up to 9 blasting machines.Several blasts may be initiated within a predetermined timeframe from one site. Each blasting machine may have its own firing time and this time is stored in the central unit. The central unit has a “master” clock that controls the time in each blasting machine giving the user full control over the firing time. The safety of the system is guaranteed by means of a unique code for each user that must be fed into the central unit before transfer can be made from the central unit to the blasting machines.

Firing of the round/s is/are made at the central unit with a firing box that is twohand operated with CHARGING and FIRING bottons. DynoRem Mine is approved by SP* and CE certified in accordance with EMC and LVD directives.

*** SwedishNational Testing and Research Institute**

NONEL Special products

Surface coated detonators - for improved corrosion resistance of the aluminum shells, especially in chemically aggressive environments Dyno Nobel manufactures detonators that are anodised and finished with laquer.

NONEL OD - At worksites where the detonators are exposed to-great strain Dyno Nobel manufactures detonators with reinforced aluminum shells.

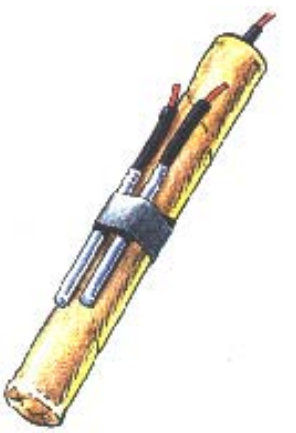
NONEL tube with other colors - NONEL detonators may be supplied with NONEL tube of a different color then standard or transparent. Technical data and other properties are not changed.

NONEL SnapLine - The previous connector block, “SnapLine” can henceforth be obtained on request. Its properties and use are in principle the same as the Ɛclip. Snapline can initiate a maximum of 5 NONEL tubes or 1 E-cord. It is available with the delay times 0 (1.75 ms),17 ms, 25 ms, 42 ms, 67 ms, 109 ms and 176 ms.

Destruction of detonators

Detonators that are too old to be used or damaged should be destroyed.
Occasionally undamaged detonators may be destroyed by blasting them together with explosive in a blasthole. Cut away the tube and drop the detonators into the blasthole, one by one.

Detonators may also be blasted by taping them to an explosives cartridge which is blasted. If the explosive cartridge is blasted in the open, take precautions against shrapnel and airborne shock waves.



When larger numbers of detonators must be destroyed or when damaged detonators must be destroyed contact Dyno Nobel or its representative for advice.

Destruction of NONEL tube

Blast away the reactive material with DynoStart and send the tube to:
- Recycling
- Garbage dump
- Burning site

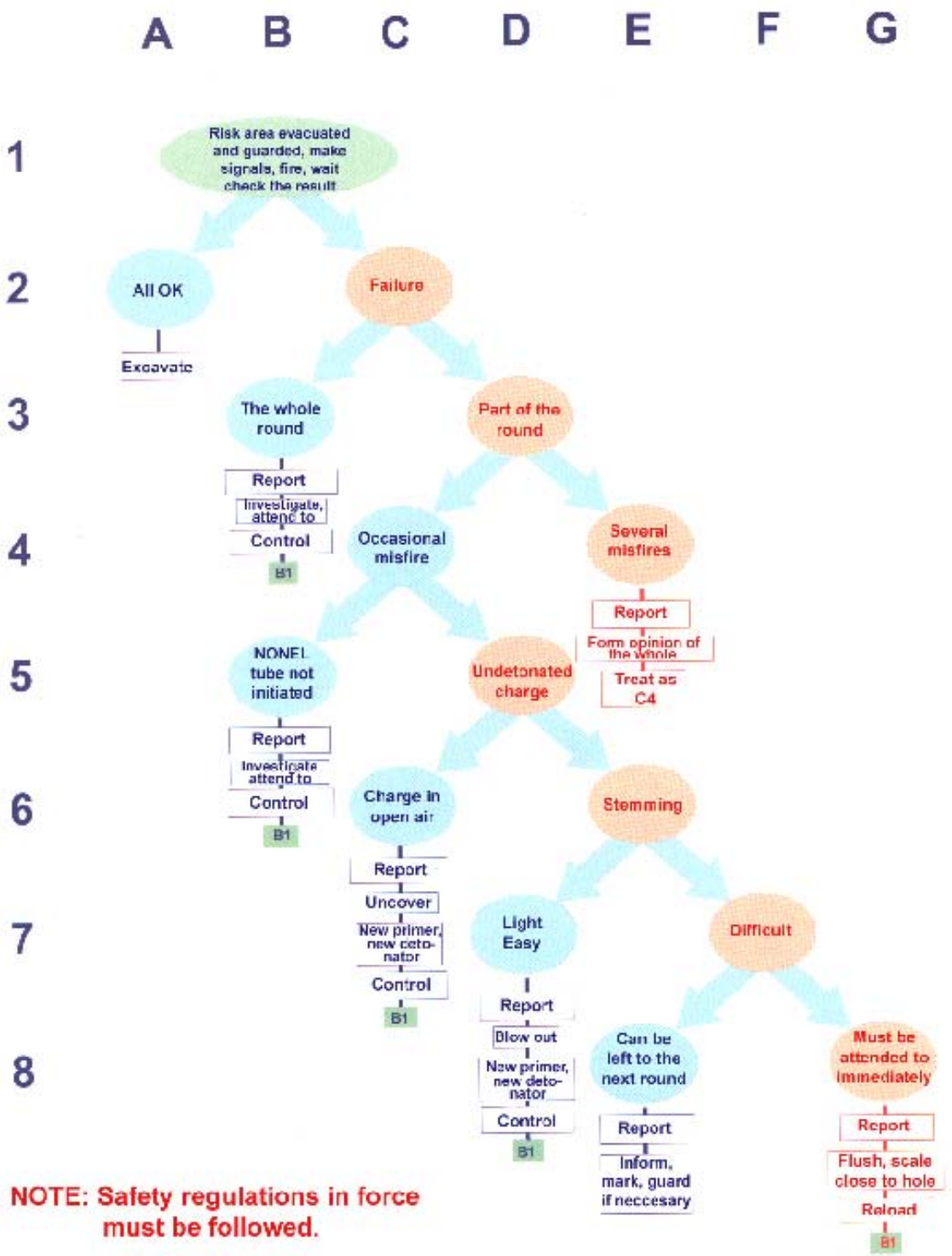
Destruction of detonating cord

- Connect to a detonator and fire it. Be aware of the risk of splinter and airshock waves.
- Drop into a blasthole together with explosive and and blast together with the rest of the round.

For additional information refer to the product Safety Data Sheet, MSDS.

Misfire procedure

In the case of undetonated holes being discovered after the blast, the following procedure can be used.



NOTE: Safety regulations in force must be followed.

Data sheet, the NONEL system

The NONEL system is not designed for use in gassy environments such as underground coalmines or other environments where explosive gases may occur nor where a dust explosion may result.

The NONEL system is approved for use only with the products that are described in this user's manual. The use of NONEL-products together with other shock tube systems is not tested nor approved. Therefore it can not be recommended neither are any guarantees given regarding function.

Recommended usage temperature	
Surface	-35°C to +50°C
Blasthole	-25°C to +70°C
Recommended storage conditions	Storage at normal room temperature, however occasionally max. +50°C and at max. RH 50%
Highest hydro static water pressure	3 bar during 7 days
Tensile strength, NONEL tube	25 kg at +20°C during 2 minutes giving a 250 % permanent stretch. 15 kg at +70°C during 2 minutes giving a 300 % permanent stretch.
Tensile strength, joint detonator/tube	4 kg during 2 minutes up to +50°C

The NONELdetonators are vacuum packed in aluminum bags. Recommended max. storage time is 2 years from date of manufacture in unopened package. Date of manufacture is stated on each product and on the packing. Products in opened package should be used within 3 months. NONEL UNIDET is normally packed in plastic bags. Recommended max. storage time for these is 2 years from date of manufacture provided good storage conditions are maintained. NONEL is packed in transport class 1.1B or 1.4B as standard, but may be packed in transport class 1.4S, which makes transport and storage much easier.

CERTIFICATE no. 15 84 01

EC type-examination certificate issued by Notified Body no. 0402

Product Type
Detonators with non-electric signal conductors (shock tubes) of low-energy type

Product Name
NONEL® detonators

Manufacturer's Name and Address
Dyno Nobel Europe, Gyttorp, SE-713 82 Nora, Sweden

Applicant's Name and Address
Dyno Nobel Sweden AB, Gyttorp, SE-713 82 Nora, Sweden

Appendix to this Certificate
Product description, technical documentation, applied standards and requirements

Marking
Products that conform with the product to which this certificate of EC type-examination relates may be marked with the CE symbol in accordance with Directive 93/15/EEC, Explosives for civil uses.

Being a notified body in accordance with directive 93/15/EEC it is herewith certified that the technical documentation and the product fulfil the requirements set out in Article 6, Module B of the Directive and also fulfil the applicable essential safety requirements set out in annex 1 of the Directive, which has been confirmed by type testing.

The manufacturer's instructions for use (in Swedish) have been examined and found to fulfil the relevant requirements in the Directive. The information in the instructions must be provided in the language that is used where the product will be sold. Manufactured products must be inspected in accordance with Article 6, Modules C, D, E or F of the Directive, and must fulfil the basic requirements in other applicable directives. Other terms and conditions are set out in SPCR 034. This certificate is the fourth edition with this number and replaces the certificate dated 20th June 2001.

Borås, 27th October 2003

SP Swedish National Testing and Research Institute
Certification

Leif-Åke Månsson
Certification manager

Åke Månsson
Certification officer

CE

NONEL®

system is

CE

certified

DYNO

Dyno Nobel

Dyno Nobel Sweden AB
Gyttorp
SE-713 82 NORA SWEDEN
Tel +46 587 85000
Fax +46 587 25535
www.dynonobel.com

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